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A LINGUISTIC APPROACH TO THE EDUCATION OF AURALLY HANDICAPPED CHILDREN

Cooperative Research Project No. 907

Mary F. Woodward

Edgar L. Lowell

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School of Education
UNIVERSITY OF SOUTHERN CALIFORNIA
John Tracy Clinic
Los Angeles, California
1964

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1. PROBLEM

The experiments described in this report were conducted as part of a research program designed to apply the principles of modern structural linguistics to problems of visual speech reception in aurally-handicapped individuals and language learning in preschool deaf children. In general, the investigation has been concentrated on a study of the visual perceptibility of English speech; more specifically, it has been devoted to a search for the linguistic determinants of perception in oral-visual communication.

The science of linguistics can have a significant role in the evaluation and improvement of techniques for teaching aurally-handicapped children. A central problem for educators of children with severe hearing losses is finding substitutes for those channels by which normal-hearing children learn to speak and understand.

Language acquisition for the deaf child depends on speech reception through lipreading, and on speech production monitored primarily by non-auditory cues. Although present tutoring techniques frequently achieve remarkable results, they might be better understood and made more effective by the systematic application of linguistic concepts and methods to the problems involved. The approach of structural linguists has already been used with great success in foreign language teaching, for example, and while this is a problem of different character and magnitude from that facing the teacher of the deaf, the two areas have much in common.

The general research framework followed here consists of a model for the analysis of lipreading, constructed on the basis of linguistic theory and method. The experimental approach has been to proceed from the descriptive units of structural linguistics, and to test the perception of these units by evoking responses to stimuli appropriate to a specific level of structure in the source language. Though the concern has been with the specific structures peculiar to English, it should be noted that the universal applicability of techniques of linguistic analysis makes the theoretical model equally useful as an approach to similar problems in other languages.

2. OBJECTIVES

The immediate goal of this research was a preliminary examination of the linguistic determinants of perception and learning in oral-visual communication and, consequently, in language development of the aurally-handicapped child. In the longer view, the program was set up as an attempt to achieve the following objectives: (a) to develop a theoretical model of the structure of perception in lipreading, that is, a definition of the units of visual perception of oral-aural stimuli and of the relationships among these units in a system of oral-visual communication; and (b) to establish the relationship of the visually-received symbols to the underlying linguistic system.

It was planned that these objectives be implemented by a comprehensive investigation which would proceed according to two principal categories of analysis: (a) communication techniques and perceptual processes, i.e., a definition of the character of the stimulus material (speech) in perceptual terms, with emphasis on visual speech reception (lipreading); and (b) education techniques and learning processes, i.e., an examination of the processes of induced language acquisition in the deaf child.

Constructed on the model of linguistic methodology, a general research design for the analysis of lipreading and language learning called for a series of experiments to test the visual perception of the analytic units of structural linguistics--beginning on the phonological level to provide a systematic basis for dealing with the more complex units of morphology and syntax.

Because basic studies of the visual perceptibility of speech, and the nature of lipreading communication, are prerequisite to a solution of more specific educational problems of the deaf, the perception experiments have had chronological priority in the investigation, and have provided the basis and the conceptual units for formulating specific questions for the language acquisition study.

By following a linguistic model, it may be possible to determine the relationships between perceptual units of English speech and the analytic units of the English language, at successive levels of English structure. It was hoped that this general procedure would lead ultimately to isolating visual (and auditory) units of signal reception as compared to the signaling units in terms of which the code itself (the linguistic system) is structured; the definition of a decoding system based on visually received speech stimuli; and an assessment of the relative communicative efficiency of such a system.

The general design for both phases of the project, then, followed a model of analysis based on linguistic theory. This model served as a source of hypotheses, and English as the test language, in a series of experimental procedures in which the results of testing were to be classified linguistically and analyzed statistically.

As a general guide, the following model was adapted from linguistics to provide tentative levels and categories of analysis for lipreading research:

1. PHONOLOGICAL
    - a. Phonetic - the visibility of physiological articulations and of the differences among them.
    - b. Phonemic - the visual perception of phonemes, i.e., the lipreader's interpretation of the visible articulatory differences, relative to the aurally perceptible contrasts of the English phonetic system.
    - c. Syllabic - the effect of syllable structure in the visual perception of speech, i.e., the selectivity which may operate in terms of the different consonant-vowel combinations permissible in English phonology.
    - d. Morphophonemic - visual perception in terms of morphologically-determined phonetic alternation.
2. GRAMMATICAL
    - a. Morphological
    - b. Syntactic
3. LEXICAL
    - a. Context
    - b. Metaphorical extension

3. RELATED RESEARCH

Earlier research from which the current project was developed has been described by Woodward (1957, n.d.), and various aspects of the present program have also been reported (Woodward and Barber, 1960a, 1960b; Woodward, 1964). For sake of completeness, relevant materials from the sources cited are incorporated in this report.

Other investigators have recently begun to apply certain linguistic concepts and methods in education programs for people with speech and hearing disorders (e.g., Albright and Albright, 1958, and Hutton, 1959). Although the work which these articles describe is complementary to the Cooperative Research Project reported here, there appear to be no other studies utilizing linguistic analysis for an investigation of lipreading processes.[1]

Structural linguists have not generally been concerned with the perceptual aspects of speech, an area which can be approached only with comparative and experimental data on different types of sensory reception. Although students of the interdisciplinary field of psycholinguistics have posed related questions (e.g., Osgood, 1954), none of these has focussed on problems of speech perception in the aurally handicapped.

In education, the application of linguistic methods has been limited primarily to the teaching of foreign languages (cf. Haas, 1953 and Whorf, 1949); otherwise, techniques and knowledge acquired during the past thirty years of development in linguistic science have been felt only sporadically in language arts teaching. In his survey, "Language Development in Children," John B. Carroll (n.d.) states:

> ....one of the most important methodological considerations is a scientific conception of the nature of language in general and of the characteristics of the particular language or languages involved in any investigation.
>
> Psychologists and educators investigating child language have generally failed to take account of advances in linguistic studies; by the same token, linguists who have studied child language have missed many opportunities for interpreting

---

[1] An extensive bibliography of lipreading research has been published by the John Tracy Clinic (Wong, Dickens, and Taaffe, 1957).

their observations in psychological terms. Psychologists should give more consideration to the linguists' units of analysis (phoneme, morpheme, etc.).

Beyond the general lack of interdisciplinary cooperation for applied research in this particular educational area, linguistic theory and data have not thus far been applied to problems of acquisition of a native language in situations where normal channels of learning (e.g., hearing) are not available.

Much material relevant to the research reported here may be found in the considerable literature on language development of normal children, but its value here is primarily for comparative purposes; psychologists and educators, as mentioned above, have not conducted their studies in linguistic terms. The normative measures of articulation, sound discrimination, sentence structure, and vocabulary found in Mildred C. Templin's Certain Language Skills in Children (1957) have so far provided the best, if not the only, comparative data for this program. Problems of translation into linguistic units and concepts, however, are present in this as well as in other sources.

4. FILM TEST I

The initial step in application of the theoretical model was designed to discover units of lipreading which are combinable into successively-larger units, i.e., which are reducible to classes of such units, and which interrelate in a system of communication.

As the ultimate functional constituents of speech, phonemes are the lowest-order units of communicative value in a linguistic system; they may be considered, consequently, as primary units in oral-aural communication--as well as in other systems which are based directly on oral-aural symbols.[2] Given the fundamental nature of the phoneme in any linguistic system, it may be anticipated that one component of lipreading comprehension should be statable in terms of the relative visibility of difference among phonemes.

Phonemes may be classified by the articulatory differences characteristic of a given phonological system, and articulations, in turn, are describable in physiological terms: according to the articulatory mechanisms employed in a given phonation, areas of articulation, types of articulation, and combinations of these (co-articulations). Articulatory differences, and their visual perceptibility, may constitute units of lipreading at the simplest level of analysis and perhaps at a basic level of visual speech reception as well. If visibility of articulation is a variable in lipreading, it should first be tested at that level at which it can be most easily controlled, i.e., at the level of phonemic distinctions--defined by phonetic dimensions.

EXPERIMENTAL DESIGN

Proceeding from these minimal analytic units of the language, the pilot experiment was set up to test the visual discriminability of the phonemic contrasts among word-initial allophones of English consonants, as indicated by the perception of differences between pairs of minimally-distinctive nonsense syllables.

Because the immediate goal was the discovery of minimum units and dimensions of difference in lipreading, it was necessary to establish a context in which no redundant features would be possible. The stimulus materials, then, had to exclude the potential redundancy of situational cues, of conditioned phonetic variation, and of lexical or grammatical context. The reference here is not to stylistically redundant expression, but rather to structural redundancies inherent in the language itself. In the utterance "two white dogs", for example, the notion of plurality is expressed twice; given the fraction "two white dog-", then the $\{\underline{-z}\}$ morpheme is highly predictable. To be non-redundant at this level, the construction might be "two white *dog" (cf. Navaho); to be consistently redundant, it might be "two *whites dogs" (cf. German).

---

[2] More explicitly, phonemes are the ultimate phonological constituents of an utterance; though they are reducible phonetically, the resultant differences are determined and non-functional.

In order to obviate the essentially dichotomous nature of the testing technique, furthermore, and to permit analysis of discrete pairs in a broader framework of phonetic pattern congruity, it was necessary to define a constant environment for the phonemes to be tested. Experimental aims required, then, that the consonantal stimuli be presented as minimal pairs in a constant phonemic environment and a non-redundant context. This particular set of conditions can be achieved for English only with stimulus materials which consist of monosyllabic nonsense words.

It is apparent that in larger utterances it would be difficult to impose adequate controls for contextual variation. The lipreader might discriminate, for example, between the words pill and bill when these forms occur in such utterances as "he swallowed a pill" and "he paid the bill", but it is not justifiable to infer from this that the lipreader has, in fact, distinguished between p- and b-; he has distinguished, rather, the contexts in which the two words occur. In these contexts, the speech sound components p- and b- are redundant, or the phonetic differences between them are redundant. That the lip reader can sometimes discriminate between forms distinguished by the voiceless-voiced consonants of English, then, does not necessarily mean that he can see the articulatory differences between them. That these consonants are visually discriminable is an assertion sometimes made by teachers of the deaf, however, and it has appeared as well in published research (e.g., Mason, 1932). A means of testing such assertions lies in the use of test materials which consist of minimally different stimuli.

In view of the various restrictions discussed above, stimulus units for Test I were selected according to the formula C_1V - C_2V (or C_1V - C_1V); for example, pa - ka (or pa - pa). The choice of a syllabic unit was restricted to /a/ and /ɔ/, the only vocalic nuclei of English normally occurring in final open syllables with primary stress without a diphthongization which might be homorganic with another vowel phoneme (Whorf, 1949, Fig. 1). The low central /a/ was selected because comparable /ɔ/ syllables yield several meaningful combinations.[3] Likewise, the use of longer or closed (CVC) syllables would have resulted in even less control for meaning.

The subject's task in the experimental situation was to respond to the members of each syllable pair as 'alike' or 'different'. Analysis of these responses was designed to establish a rank order of visual perceptibility of consonant phonations, and from this, a hierarchy of visual contrastiveness among the phonetic differences which are assumed to be crucial in the auditory reception of speech.

Experimental Sample. According to the requirement that every phoneme be in some way contrasted with every other in experiments of this kind (Hoijer, 1957, pp. 19-20; Miller and Nicely, 1955), materials were selected so that every classificatory dimension of the English consonantal system is represented in the sample. In other words, every criterion was to be tested against every other, though not all specific combinations resulting from cross-cutting criteria were to be compared with all others.

The following classificatory criteria were used as a guide for postulating a structure of visual relationships among consonantal articulations, and for selecting the specific pairs to be tested in these terms: (a) type of articulation (stop, affricate, spirant, resonant), (b) area of articulation (bilabial, labiodental, dental, alveolar, alveopalatal, velar, glottal), (c) resonance type (oral, nasal), and (d) coarticulations (voicing, affrication, palatalization, labialization). It should be noted that, with the exception of voice, the variations listed as co-articulatory phenomena could be accounted for simply as combinations of difference in area and type of articulation. The additional dimensions were included, however, so that we might examine certain relationships which are not explicit in the basic classification. Still other distinctions characteristic of English phonology (e.g., aspiration and force of articulation) were omitted as explicit variables since they may be subsumed under the voiceless-voiced contrast in the particular consonantal environment set up (initial position of a stressed syllable).

In terms of the categories derivable from these criteria, every consonantal phoneme of English can be differentiated from every other; that is, any pair of consonants can be distinguished along one or more of the phonetic dimensions significant in English phonology. By testing visual responses to phonetic differences between selected consonant pairs, therefore, it should be possible to isolate critical dimensions of the visual difference among these phonemes--that is, the dimensions in terms of which articulations may be apprehended visually and interpreted phonemically. More explicit rationalization, perhaps, for such procedures may be found in the theoretical position of Prague School linguists who tend to regard these dimensions of phonetic contrast as the phonemes of a language (e.g., Martinet, 1949, and Jakobson, et al, 1952).

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[3] Specifically, the vocalic nucleus selected is phonetically a long [a·] sometimes phonemicized as a simple vowel plus mid-central glide: /ah/ (Gleason, 1955, pp. 33-39; Trager and Smith, 1951). For the sake of simplicity, it is written here as -a.

Hypotheses. On the basis of the phonetic dimensions outlined above, a general hypothesis of differential visibility of phonation was set up, and from this was derived a major hypothesis of differential visibility of contrast (see Table 1):

Hypothesis 1: absolute visibility of phonation is a function of area of articulation.

Hypothesis 2: visibility of contrast is a function of relative visibility of phonation.

The prediction of the first hypothesis, more specifically, is a positive relationship between lip movement and visual perceptibility of the phonation. It was postulated that a rank order of visibility could be established as follows:

(1) labials and labialized consonants /p b m f v W w r/
(2) alveo-palatals /č ǰ š ž x y/

---

(3) alveolars and dentals /t d n l s z θ đ/
(4) velars and glottals /k g h ɸ /

where (1)-(4) is not an equally descending scale, but a sharply dichotomous one in which (1) and (2) are highly visible, and (3) and (4) are barely visible. This particular division of the hypothesized visibility continuum was made because informal pretesting showed a discernible amount of labial involvement in alveo-palatal articulations, and little or none for the alveolar, dental, velar, and glottal articulations. The results of the study did not bear out this aspect of the hypothesis.

Hypothesis 2 was specified in terms of each of the consonantal articulations, so that a prediction was made about the degree of visual difference between members of all possible pairs of English consonant initials, and the pairs to be tested were selected to be representative of

TABLE 1

POSTULATED VISIBILITY OF PHONATION AND VISIBILITY OF DIFFERENCE*

ARTICULATION TYPE		AREA OF ARTICULATION				
		Velar, Glottal	Alveolar, Dental		Alveo-palatal	Labial, Labialized
Stops and Affricates	Vl.	k-	t-		č-	p-
	Vd.	g-	d-		ǰ-	b-
Continuants			n-			m-
			l-			
Spirants	Vl.		s-	θ-	š-	f-
	Vd.		z-	ð-	*ž-	v-
	Vl.	h-				W-
Semi-Vowels	Vd.	∅				w-
					y-	r-

KEY: (–) ——— VISIBILITY OF PHONATION ——— (+)

VISIBILITY OF DIFFERENCE: Contrastive (———)
Similar (- - -)
Equivalent ( )

---

*Distinctions of voice are shown only for those consonants which are members of voiceless-voiced sets (indicated above by Vl. and Vd., respectively). The remaining consonants on the chart are typically voiced, and where voiceless counterparts to these occur, the difference is sub-phonemic. For examples of phonemic symbols, see Pronunciation Key, Appendix A.

these differences. Specific predictions were made by a classification of all pairs into three hypothetical categories of variation, representing predicted response frequencies: *visually contrastive*, *visually similar*, and *visually equivalent* (cf Table 2). "Contrastive" was a prediction that most subjects would call such pairs "different"; "equivalent" was a prediction that most subjects would call such pairs "alike". Pairs classified as "similar", on the other hand, express relationships for which no *a priori* criterion justified a prediction of either contrastiveness or equivalence: these pairs, consequently, were assigned arbitrarily to an ambiguous range in which it was expected that comparisons would evoke both "alike" and "different" responses. Functionally, of course, such a classification is dichotomous, since "similar" pairs may be grouped with "equivalent" ones, as opposed to those pairs showing articulatory differences which have contrastive value in lipreading.

From the terms of Hypothesis 2, all pairs of homorganic consonants and all pairs of alveolar, dental, velar, and glottal consonants which are neither palatalized nor labialized were expected to fall into the visually equivalent or visually similar categories. Accordingly, consonants at the positive end of the visibility axis (Table 1) were expected to be characterized by greater differentiation than those at the negative end.

In comparison with the dimensions which define differences in auditory reception of speech, these postulated visual relationships among English consonants indicate a marked leveling of distinctions. Dimensions of articulatory type, resonance, voice, affrication, and several areas of articulation which are functionally different in English phonemics would not, in terms of these hypotheses, have phonemic value in the visual perception of English speech.

Stimulus Materials. In addition to the 22 word-initial consonants listed in most phonemic analyses of English (e.g., Trager and Smith, 1951; Gleason, 1955), three other syllable-initial positions were tested: /ž/ was included in the sample to complete that pattern of voiceless-voiced contrast, e.g., /š : ž ≅ t : d/, and to permit a further check on the effect of palatalization on contrastive visibility, e.g., /z : ž ≅ s : š/. Zero consonant initials /∅/ were included not only as a possible index of absolute visibility, but also to provide hypothetical base forms for measuring coarticulatory phenomena, e.g., /∅ : y ≅ s : š/. For classificatory convenience, syllables beginning with zero, written *aa*, were regarded as voiced counterparts of *h*-syllables, *ha*. The cluster /hw/ was treated as a unit voiceless phoneme /W/ to allow such comparisons as /h : W ≅ ∅ : w/.

TABLE 2

EXPERIMENTAL SAMPLE

	p b m	f v	W w r	č ǰ š *ž y	t d n l θ đ s z	k g h ∅
p	∅ = =	+	+	+	+ +	+ +
b	= ∅ =	+	+		+	+
m	= = ∅				+	+
f	+	∅ =	+ +	+		+ +
v	+	= ∅	+		+ +	+
W	+	+	∅ =	+		++
w	+	+	= ∅ -	+	+	++
r		+	- ∅	+	+ + + + + +	+ +
č				∅ = - -	+	+ +
ǰ				= ∅ - -	+	+
š	+	+	+	- ∅ = -	+ + +	+
*ž				- = ∅ -	+ + +	+
y			+ +	-- - - ∅	+ +	+ +
t	+		+	+ +	∅ = = - -	- -
d	+ +		+	+ +	= ∅ = = - - - -	- - -
n	+		+		= = ∅ =	-
l			+ +	+	= = ∅	-
θ					- - ∅ = -	-
đ		+			- = ∅ -	-
s			+	+ + +	- - - ∅ =	- -
z		+	+	+ +	- - = ∅	-
k	+	+		+	- -	∅ = = =
g			+	+	-	= ∅ = =
h			+ +		-	= = ∅ =
∅	+ + +	+ +	+ + +	+ + + + +	- - - - - - - -	= = = ∅

KEY: (∅) PHONEMICALLY ALIKE 25

PHONEMICALLY DIFFERENT:

(=) Visually Equivalent 40

65

(-) Visually Similar 54

119

(+) Visually Contrastive 110

TOTAL 229

By varying these 25 initial consonants, as well as the order of syllables within each pair, 625 different syllable pairs can be derived, 25 of which contain phonemically identical members. Stimulus materials for Test I consisted of 229 of these pairs. To control for sequence of presentation, each phonemically-different pair of consonants selected was presented in both possible orders, e.g., pa - ka and ka - pa. Test materials included all identical pairs (25), all zero combinations (49, including aa - aa), all voiceless-voiced comparisons (20, including ha - aa), and a selected sample of syllable pairs differing by one or more of the other classificatory criteria. The experimental sample is summarized in terms of the major hypothesis in Table 2.

Experimental Procedures. Because uniformity in the presentation of stimuli was considered desirable, these materials were filmed for administration of the test. The syllable pairs selected were alphabetized according to the classificatory order established in the hypotheses (cf. Table 2) and were then randomized by means of a table of random numbers. A film script was prepared, utilizing the random order list of syllable pairs numbered from 1 to 229 (see Appendix C). The test was recorded on black and white sound film, showing a face-on view of the speaker, including the head and shoulders. Although there were reasons for suspecting that the direct full-face view is not necessarily the most critical one for perceptibility in lipreading, this is the view traditionally recommended for lipreaders, and it was selected for that reason (cf. Film Test II).

The completed film test was administered to 185 experimental subjects, 65 auditory control subjects, and 55 audio-visual control subjects, most of whom were undergraduate students at the University of California, Los Angeles. All were adult normal-hearing speakers of English.[4] Experimental groups took the visual form of the test, i.e., the film was shown without sound; for the auditory condition, the sound track alone was presented, but item numbers were shown on the screen; audio-visual groups saw the complete film with sound. All subjects were supplied with numbered answer sheets on which they could indicate whether they thought the members of each syllable pair were "alike" or "different". Instructions given to experimental groups are included in the test cover page reproduced as Appendix B of this report.

Analysis. Techniques for application of the theoretical model were developed in a preliminary analysis of data collected from the first two test groups (N = 38), and were then applied to responses obtained from the total experimental sample of 185 subjects. It is perhaps a reflection of the systematic nature of linguistic behavior and, consequently, of the aptness of a linguistic model for lipreading research, that no major changes in results accompanied the almost five-fold increase in the number of subjects tested.

---

[4] A form of Test I (modified because of film damage) has also been given to students at the California School for the Deaf, Riverside, but analysis of these data has not been completed.

To rank syllable pairs in a descending scale of visual discrimination, each of these was rated in terms of the difference between the proportions computed for alike-different responses; thus, a discrimination value for each pair was derived by subtracting the percentage of "alike" responses from the percentage of "different" responses to that stimulus unit. A rating based on the difference between response proportions, rather than on a sum of "different" responses to the pairs, factors out omissions, which were low in number and random in distribution.

Discrimination values for reciprocal pairs were then added together to yield a visual difference rating for each consonant combination. For example, eight subjects called the syllable pair pa - ka "alike" and 177 called it "different," 4 percent and 96 percent respectively, giving a discrimination value of .92. For the pair ka - pa, 11 subjects called it "alike" and 174 "different," 6 percent and 94 percent respectively, giving .88. The visual difference rating for the consonant pair /p-k/, then, is 1.80 (Rank 10, Appendix E-1). Visual difference ratings for all combinations tested were then placed in a rank order of visual difference, and it is in terms of this ordering of the data that the major hypothesis specifying the differential visual contrastiveness of initial allophones of English consonants was assessed.

Although an arrangement of visual difference ratings in a descending scale would extend theoretically from +2.00 to -2.00, actual results show a range from +1.98 to -1.56. This range was divided into three major classes which correspond roughly to the differential categories established in the hypothesis: (a) contrastive, ratings from +1.98 to -1.44; (b) similar, from +1.33 to -.06; and (c) equivalent, from -.02 to -1.56. This division was made primarily on the basis of phonetically comparable relations since in most cases it was possible to include within one group such pairs as /b-d/, +1.87; /p-t/, +1.82; and /m-n/, +1.86; these pairs include bilabial and alveolar consonants of comparable articulatory type. The specific consonant pairs included in each of the classes are given in Appendix E-1, which shows 44 pairs labelled contrastive (ranks 1-24), 34 similar (ranks 25-55), and 24 equivalent (ranks 56-78). The visual difference values on which this ranking was based are listed in Appendix D (visual column).

RESULTS

· Experimental Data. On the basis of this analysis, the hypotheses of absolute and relative visibility of English initial consonants were tested. The degree of articulatory differentiation, decreased by the hypotheses in moving from auditory to visual conditions of reception, was reduced to an even lower level by the results of the study. Of those phonetic dimensions which define the significant articulatory differences in English speech, almost all--including articulation type, resonance type, voice, affrication, palatalization, and all areas of articulation except the labial--are virtually neutralized as factors of difference in visual perception.

In terms of these data, the following four sets of English consonant initials can be classified as visually contrastive:

Unit 1: p b m
Unit 2: W w r
Unit 3: f v
Unit 4: t d n 1 θ đ s z č ǰ š ž y k g h

The four units may be categorized briefly as bilabial, rounded labial, labio-dental, and nonlabial, respectively. While these units contrast visually with each other, they are internally homophenous, that is, the members of each unit look alike to the lipreader. While reference to Table 1 shows that /f/ was confused with /r/ (Rank 31) and /v/ with /đ/ (Rank 33), Unit 3 is regarded as distinctive because /f/ and /v/ contrast with all other members of the other three units.

Even though Unit 4 was set up on the basis of visually-similar as well as visually-equivalent relationships, it is apparent that lipreaders cannot discriminate consistently among the individual phonemes included. If lipreaders are to distinguish these various types of phonemes--alveolar, dental, alveopalatal, velar, and glottal--it must be on the basis of phonetic, lexical, or grammatical redundancy, since the articulatory differences among them are not readily available to visual observation.

Although responses to pairs containing a zero syllable (aa) were not diagnostic of a differential absolute visibility of consonant phonemes, other syllable-pair comparisons permitted an analysis of similar order. From the distribution of consonant pairs among the three major categories of contrastive, equivalent, and similar, a high visibility value can be inferred for the labial and labialized consonants (Units 1, 2, and 3 above) since they contrast with all the members of all other units. Further, except for the zero combinations, no nonlabial consonant participated in a visually contrastive pair unless the pair also included a labial or labialized consonant. The fact that only labial articulations are discriminated consistently seems to justify the term "lipreading" for this level of activity in visual speech reception.

Perhaps the most notable failure among the predictions of differential visual perceptibility of consonant phonemes is the refutation of the high visibility which the hypothesis assigned to the alveopalatal consonants, and their participation, consequently, in fewer visually contrastive pairs than was postulated. Not only were these phonemes distinguished from alveolar consonants to a much lesser degree than was predicted, but also they constituted among themselves a virtually homophenous unit. Because it seemed possible that lip movement in palatalization might be more visible with a profile view of the speaker, a test of this hypothesis was incorporated in subsequent experiments (see Film Test II).

Comparison of Experimental and Control Data. Criteria used in assigning specific consonant pairs to Equivalent, Similar, and Contrastive categories of the Rank Order of Visual Difference have been outlined above. Comparable techniques were used in processing auditory and audio-visual data, except that the boundaries of distinction along these continua were determined directly by the numerical perceptual difference ratings derived by analysis of visual tests.[5] (A comparative Index of Perceptual Difference for all consonant combinations as visual, auditory and audio-visual stimuli is reproduced as Appendix D of this report, and a Rank Order of Perceptual Difference for each of the three stimulus conditions may be found in Appendix E).

Of 102 possible distinctive pairs among the analytic units tested, 44 were visually contrastive, 79 were aurally contrastive, and 85 pairs came within the contrastive range under audio-visual conditions of reception. These distributions are specified in Table 3. This tabulation of results would seem to indicate that phonemic distinctions are most easily perceived under audio-visual conditions, that they are slightly less perceptible from auditory cues alone, and that fewer than half the analytic distinctions are visually perceptible. This gross distribution might easily have been assumed, of course, before the analytic units were actually subjected to perceptual testing, but beyond this, the experiment has yielded characteristic perceptual patterns for the three conditions of reception.

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[5] Because it was anticipated that auditory and audio-visual control groups would achieve "perfect" scores (except for errors due to random distractions in the test situation), no specific hypotheses were formulated in advance of actual testing. In view of the assumed validity of the analytic units of linguistic methodology, in fact, there would have been no logical justification for postulating the differential dimensions of perceptibility which were actually obtained (cf. Tables 5 and 6).

TABLE 3

CONTRASTIVE AND NON-CONTRASTIVE DISTRIBUTIONS FOR THREE STIMULUS CONDITIONS

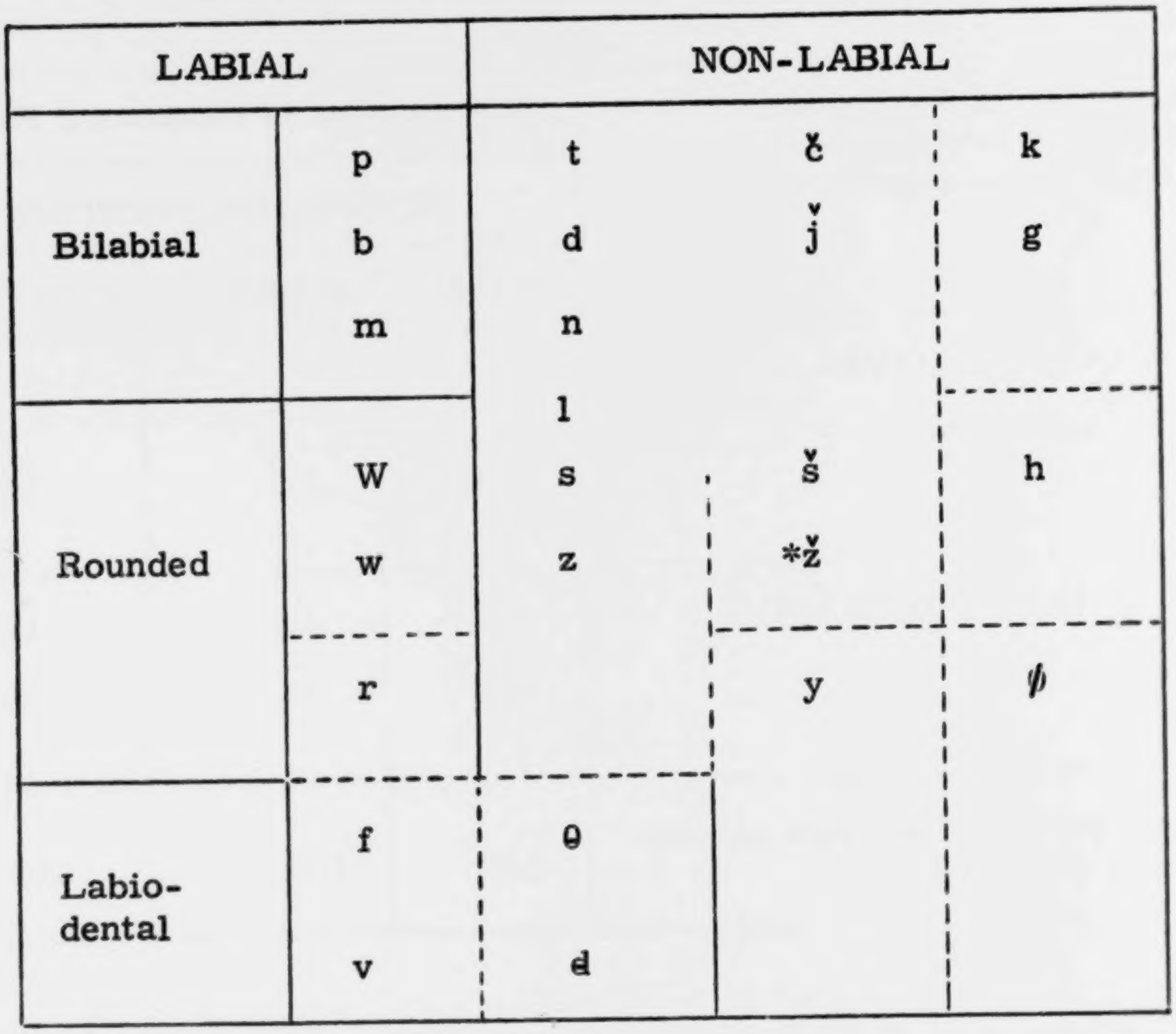
Categories of Perceptual Difference between Paired Initial Consonants	Distribution of Consonant Pairs		
	STIMULUS CONDITION		
	Visual	Auditory	Audio-Visual
NON-CONTRASTIVE:			
Equivalent	24	4	1
Similar	34	19	16
TOTAL NON-CONTRASTIVE	58	23	17
CONTRASTIVE	44	79	85
Total Analytic Contrasts among Tested Consonants	102	102	102

For visual and auditory conditions, a clear-cut patterning of responses can be stated in terms of specific phonetically defined dimensions of perceptibility. In spite of the results (and common sense reasoning) which point to audio-visual reception as the optimum condition for speech perception, the audio-visual data are characterized by discrete inconsistencies--deriving perhaps from a difficult control situation. The general pattern of audio-visual perception can only be inferred from its auditory and visual components.

Results of analyses of the specific consonant relations tested, and the structuring of responses according to contrastive and non-contrastive articulatory dimensions of the three stimulus conditions, are summarized in Tables 4, 5, and 6.

TABLE 4

PERCEPTIBILITY OF DIFFERENCE AMONG CONSONANT INITIAL ALLOPHONES AS VISUAL STIMULI



LABIAL		NON-LABIAL		
Bilabial	p	t	č	k
	b	d	ǰ	g
	m	n		
		l		
Rounded	W	s	š	h
	w	z	*ž	
	r		y	∅
Labio-dental	f	θ		
	v	ð		

KEY (Visibility of Difference):

Contrastive (______)
Similar (- - - -)
Equivalent ( )

For the lipreading condition (Table 4), we have isolated four visually perceptible units of consonant articulation. Because of the distribution of homophenes among the four contrastive units, it can be stated that the only articulatory dimensions which are significant in visual speech reception are those defined by lip movement: three different combinations of labial articulation (Units 1 to 3) and one unit (No. 4) characterized simply as non-labial. At the phonetic level, then, visual speech perception is determined by four functionally different areas of articulation: extended bilabial, rounded bilabial, labio-dental, and non-labial.

As compared to this simple consonant system available to the lipreader, auditory reception shows a highly differentiated set of ten contrastive units which vary in terms of the several phonetic dimensions (cf. Table 5) derivable from the following organization of analytic homophones:

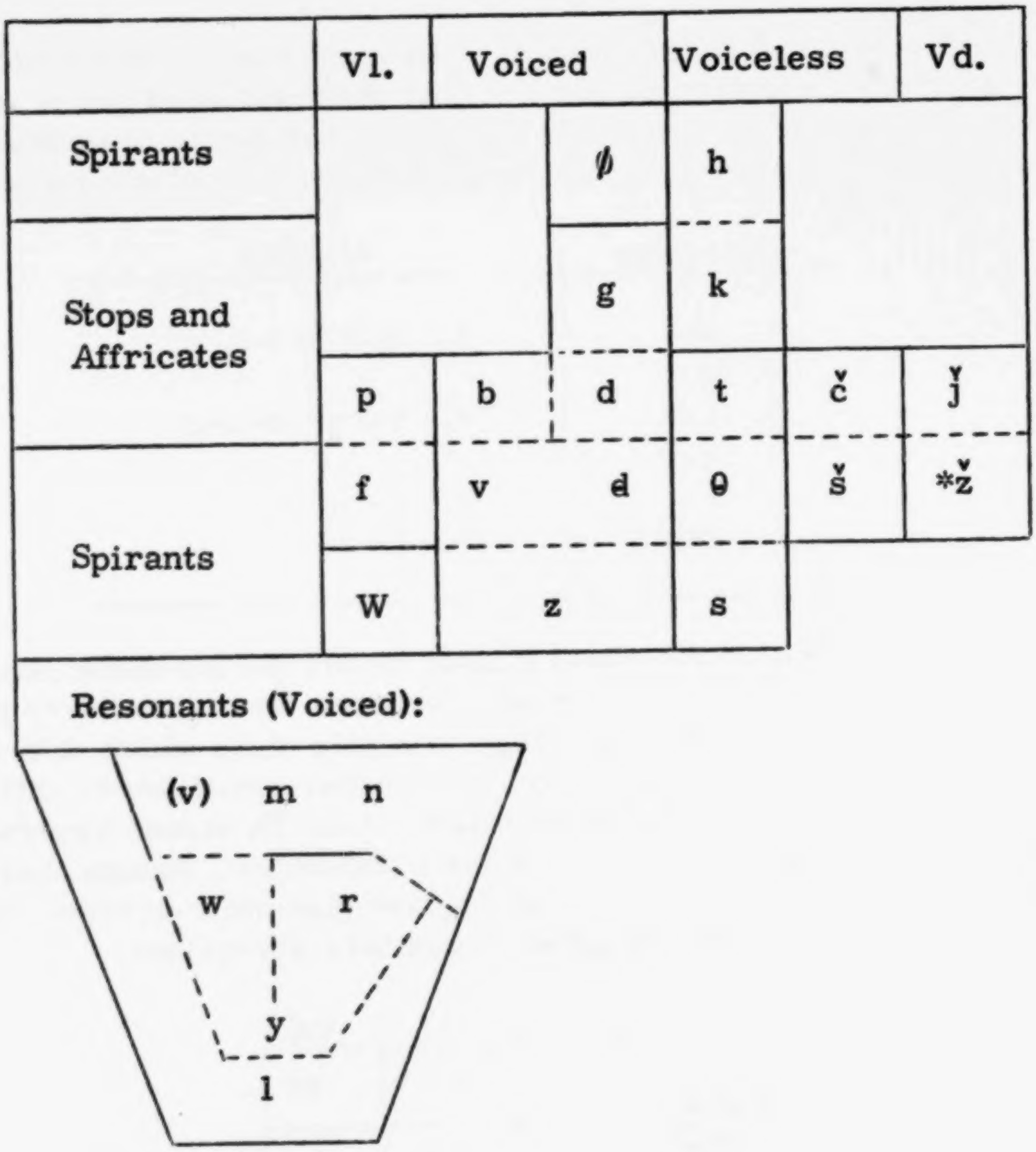
Voiceless /	Voiced
1. W	7. w-r-y-l-n-m
2. p-f	
3. t-θ	8. b-v-z-đ-d-g
4. k-h	
5. č-š	9. ǰ - ž
6. (θ)- s	10. (đ-z)

As indicated by the chart (Table 5) and the phoneme list above, the primary cross-cutting dimension of difference among auditory perceptual units is defined by the feature of voicing; analytic units which differ in these terms are likewise aurally contrastive. The other articulatory differences significant in aural perception, furthermore, must be stated separately for the two categories of the basic voiceless-voiced distinction; though there are more voiced than voiceless consonants in the English phonemic system, the voiceless units show greater differentiation in auditory reception:

	Vl.	Vd.
Analytic Units	10	14
Aurally Perceptible Units	6	4

TABLE 5

PERCEPTIBILITY OF DIFFERENCE AMONG CONSONANT INITIAL ALLOPHONES AS AUDITORY STIMULI



	Vl.	Voiced		Voiceless		Vd.
Spirants			∅	h		
Stops and Affricates			g	k		
	p	b	d	t	č	ǰ
Spirants	f	v	đ	θ	š	*ž
	W	z		s		

Resonants (Voiced):

For key, see Table 4.

Given the feature of voicelessness, we find that auditory units are distinguished according to five areas of articulation:

1.	Rounded labial	(W)
2.	Extended labial	(p-f)
3.	Alveolar-dental	(t-θ, θ-s)
4.	Velar-glottal	(k-h)
5.	Alveo-palatal	(č-š)

Assuming homorganic units as defined by these five categories, however, the following analytic distinctions of articulatory type are homophonous (for both voiceless and voiced units), leaving only three dimensions of difference in these terms:

1. Stop-slit spirant[6] (t-θ, p-f, k-h; d-đ, b-v)
2. Affricate-groove spirant (č-š; ǰ-ž)
3. Slit spirant-groove spirant (θ-s; đ-z)

Among the voiced consonants, the resonants constitute a single contrastive unit, and the labial, alveolar, and velar areas of distinction fall together (b-d-g). Otherwise, dimensions of similarity and difference follow the pattern given for voiceless units, and result in comparable homophones of articulatory type (d-đ, b-v; ǰ-ž; đ-z).

Although a difference between four visual units and ten auditory units may not seem great, implications of this disparity for the relative communicative efficiency of visually-received and aurally-received speech stimuli become obvious in an extrapolation of these units to a hypothetical first-order CVC combination. Assuming identical phonological function (distribution)--except for initial and final restrictions--of the consonant units,[7] given a constant vocalic environment, and excluding the effect of higher-level redundancy, we find that the four visual units have a combining potential of only 16 morphemes, while there are 90 such permutations of consonant discrimination among the ten auditory units (representing ten syllable-initial and nine syllable-final positions). As perceptual units, neither visual nor auditory phonemes, of course, approach the combinatory potential (484) derivable from 22 syllable initial positions and 22 syllable final positions represented by the 24 analytic units. (W- and h- are syllable initials only; -ž and -ŋ are limited to final position).

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[6] Slit spirants are f, v, θ, đ, h; groove spirants are s, z, š, ž. It was not necessary to observe this classificatory distinction until auditory control group data were processed.

[7] Though this assumption is a gross oversimplification of the facts of English phonology, it is by no means inconsistent with its rules. A test of perceptibility of final consonants would include -ŋ, and omit the W- and h- of the pilot study sample; (it should be noted that -ž must likewise be restricted to final position in computing possible combinations). Pending discovery of some law of consonantic harmony in English, however, the possibility for all other combinations is inherent in the system, whether or not they actually exist in the lexicon.

The cumulative effect of difference from level to level may be illustrated by tabulating hypothetical combinations for the four visual units:

Visually Contrastive Units*	Potential CVC Morphemes			
p	pVp	wVp	fVp	tVp
w	pVw	wVw	fVw	tVw
f	pVf	wVf	fVf	tVf
t	pVt	wVt	fVt	tVt
4 units	16 morphemes			

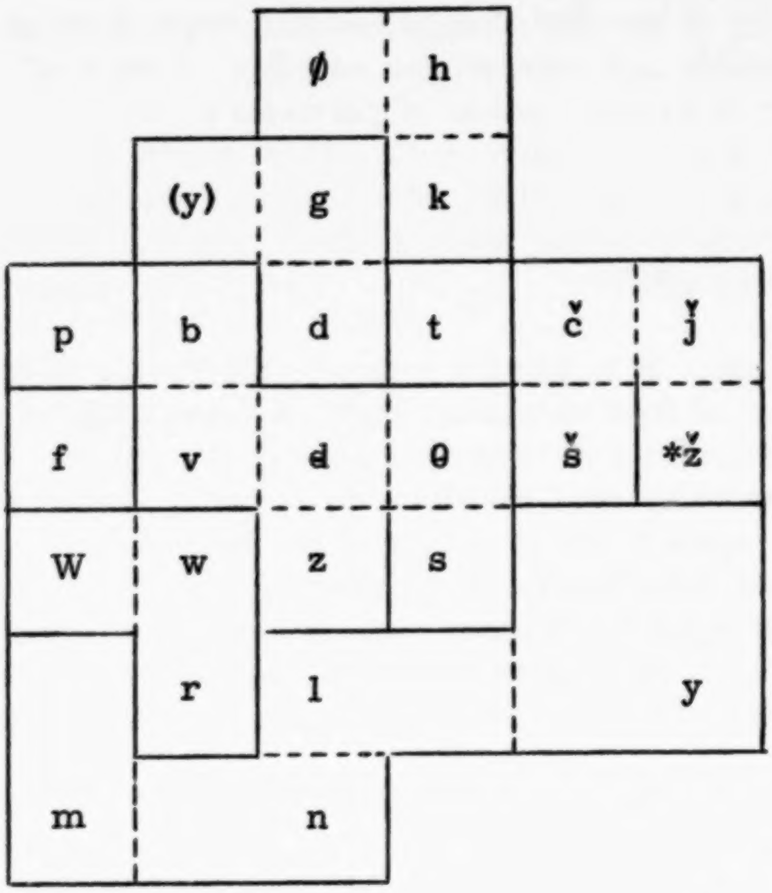
*Visual units are symbolized here by one analytically defined member of each homophenous set; e.g., visual unit p = analytic units p, b, and m. (Similarly, auditory unit p = analytic units p and f).

Examination of Table 6 reveals that testing under audio-visual stimulus conditions is not susceptible to the order of control (in terms of the hypotheses) that is possible with visual and auditory stimuli. Our data do not warrant, therefore, an inventory of "audio-visual phonemes" comparable to the contrastive units derived for visual and auditory speech reception.

Audio-visual perception of phonemes must certainly depend on auditory and visual cues to phonetic difference, but these are not relatable systematically in a given experimental situation. Under visual

TABLE 6

PERCEPTIBILITY OF DIFFERENCE AMONG CONSONANT INITIAL ALLOPHONES AS AUDIO-VISUAL STIMULI



conditions, the subject must react visually, because there is no sound to depend on; under auditory conditions, there are no visual cues. With audio-visual stimuli, however, there is no way to control for utilization of all the cues available at any one time. Consequently, though audio-visual response relationships between members of discrete consonant pairs can be rationalized easily in terms of the auditory and visual results (cf. Appendix D), the audio-visual data per se do not yield a set of perceptual units which can be classified according to analytic dimensions of similarity and difference.

Given the audio-visual stimulus condition, then, and the level of perception at which we have been operating experimentally, there is no system of prediction. On the other hand, while it may be impractical to extrapolate from these audio-visual data to other situations, it should be remembered that this study was a test of "pure" articulatory perceptibility, and there was no reason to assume that the same inconsistencies would characterize higher levels of speech perception. It was decided, then, that audio-visual controls should be maintained in subsequent experiments when other linguistically defined cues were to be included in visual and auditory stimuli (cf. Test II).

It should be noted here, however, that for auditory and audio-visual conditions of reception, deviations from the scores expected may have been a function partly of the low-fidelity sound reproduction in the test film. Although this possibility may lessen the validity of generalizations about auditory and audio-visual perception of phonemes, the results are suggestive, and they are useful as comparative data. It is worth noting, further, that under less-than-optimum conditions of auditory reception, perceptual confusions are more likely to occur among some phonetic stimuli than among others (Miller-Nicely, 1955).

Discussion. It is hardly conceivable that a useful decoding system can be based on a set of four minimal units of visual signal reception, when the code itself is structured in terms of 24 signaling units. It is apparent, however, that congenitally deaf children do, in fact, learn language, and that they do acquire speech which is based on the larger, more flexible system of aurally perceptible differences representing English phonology. It is equally apparent that speech elements which are intelligible to totally deaf individuals may differ from others--in articulatory terms--by no more than did the minimally distinctive nonsense syllables of this experiment.

Although for the severely deaf, reception of speech stimuli is limited to techniques of lipreading, the data of this study suggest strongly that the perception of speech by the aurally deprived individual (and probably by the aurally normal individual as well) involves much more than an ability to make judgments--phonetic or visual, conscious or unconscious--about articulatory movements and the visual or acoustic results of these. Lipreading is the point of transfer from the oral to the visual in speech reception, but it must be in the character of language itself as a meaningful, functioning system that the determinants of speech perception will eventually be found--even for the perception of phonemic-level distinctions among speech components.

5. FILM TEST II

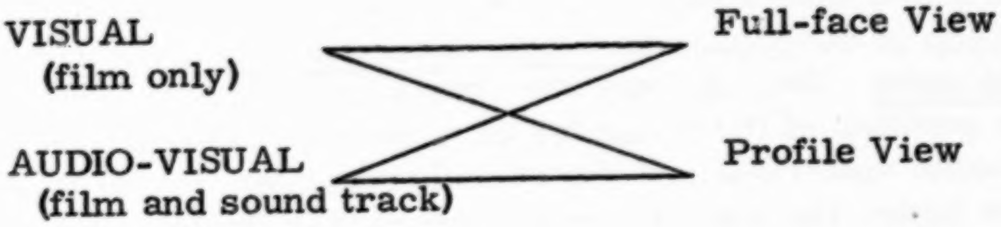
EXPERIMENTAL DESIGN

Experimental design will be discussed according to the following outline: Part One, Experimental Procedures; Part Two, Classification of Variables; Part Three, Classification of Hypotheses; and Part Four, Classification of Stimulus Materials.[8]

Part One: Experimental Procedures

Test II of the experimental series was recorded on black and white film at two camera angles: a full-face view of the speaker, and a 45-degree profile angle. To allow for complete intersection of control variables, both view-experimental and view-control films were recorded with sound.

As a result of these recording methods, it was possible to present the Film Test under five stimulus conditions:



AUDITORY (sound track only)

The total length of the test was limited to 30 minutes including filmed instructions and a sample stimulus-response unit. Intervals for the recording of responses were edited into the film, and did not impose any requirements of timing on the speaker.

A film script was prepared from a randomized order of the 198 stimulus units selected for the experiment (see Appendix G). Stimuli were presented as discrete monosyllabic utterances, and each occurred only once in the test. The stimulus utterances were preceded by numbers in the film, and corresponding numbers appeared on the answer sheets to facilitate recording of responses.

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[8] It should be noted that the numbers which identify categories and sub-categories of the hypotheses (Part Three) and the stimuli (Part Four) refer to corresponding numbers in the classification of variables (Part Two). This system of cross-reference was also followed in compiling a catalogue of stimulus materials for film production and for analysis of responses.

The cover pages for answer sheets (see Appendix F) duplicated and expanded the filmed instructions for the experimental task, and also provided space for relevant personal data; (subjects were classified for differential age, sex, native language, degree and duration of hearing loss, if any, and impairment of vision). The task of the subject in the basic form of the test was to write the stimulus word as he perceived it, using conventional English spelling to record his responses.[9]

Film Test II was administered to 428 subjects. The core population for both experimental and control groups at this test level consisted of adult normal-hearing speakers of English. Subjects were drawn primarily from university classes in the Los Angeles and Berkeley areas. Two copies of the films were made to allow for concurrent administration of the test in both areas.

It was planned that analysis of data for the basic form of the test outlined above should begin with the construction of confusion matrices for comparison of responses *in terms of the phonemic components of the stimulus units*. That is, any one confusion matrix is concerned only with a single position of the formulae of phonological structure represented in the stimulus materials. If the stimulus unit *bit*, for example, elicits the response *bean*, the matrix comparing vocalic nuclei would show that /i/ had been perceived once as /iy/; the *t-n* confusion would, of course, be tabulated in the matrices for final consonants (cf. Table 10). In this way, a limited number of stimulus units were utilized to test hypotheses of perceptual relations among a large number of phonological variables.

Part Two: Classification of Variables

As discussed in Section 4 of this report, Test I of the experimental series was limited in variables to the phonetic dimensions which define consonant-initial allophones of English phonemes in a constant vocalic environment

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[9] It should be noted that given serial presentation of discrete stimulus units, a number of test variations can be achieved simply by use of different instructions and answer sheets. One such variation was designed to examine certain paired relations of specific phonetic difference by presenting the subject with a two-way choice of responses for each of two stimuli; e.g., 1. beat___ bit _X_ .... 29. beat_X_ bit___. (cf. Film Test IV).

(-a.) and a single lexical environment (zero). Test II, on the other hand, introduced a number of controlled phonological variables using actual items of English vocabulary.

Stimuli for Test II consisted of uninflected monosyllabic English nouns, selected according to the structural formulae CVC and (C) CCVC, where the C-position may be filled by a consonant, including zero and semi-vowels, and where V = vowel or V + semi-vowel.[10] Thus, morphological type and complexity were controlled, and though the stimulus units varied lexically, grammatical meaning was held constant. It should be noted that use of the zero consonant position in the formulae for Test II has the effect of allowing comparisons between consonants and vowels as well as among the different vocalic nuclei included in the stimulus materials.

It was estimated that the 198 stimulus items, presented at the rate of 8 words per minute, would be adequate to test a number of hypotheses derived from the phonologically-defined variables outlined below. It should be noted that single lexical items, by virtue of various features of phonological structure, were utilized without repetition to test several different hypotheses.

This experiment may be viewed as consisting of the following six sub-tests which conform to the phonological and morphological criteria selected for stimulus units:

I. View-Angle Hypothesis

The entire test was recorded both as a full-face view film and as a profile-angle film. Thus, profile-view was a cross-cutting control for tests of all discriminations and, in addition, a restricted variable for a specific view-angle hypothesis of crucial phonetic relationships.

It is conventional, in education of the deaf, to recommend a full-face view of the speaker for maximum lipreading efficiency. Certain items in the literature devoted to lipreading training reflect, at the same time, an opinion that alveo-palatal and interdental spirants are among the most highly visible articulations of English speech.[11] Pilot Study results from stimuli controlled for all but articulatory variation, however, indicated that one of these traditionally-held notions must be inaccurate or, at the very least, misleading (cf. Test I).

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[10] All formulae for stimulus selection for Film Test II were derived from the Structural Formula of the Monosyllabic Word in Standard Midwestern American English (Whorf, 1949, Fig. 1).

As a technique to test the reliability of these conflicting assertions, it was hypothesized that given a partial profile view of the speaker, the alveo-palatal consonants (č, ǰ, š, y) and the slit dental spirants (θ and ð) would attain visually-contrastive scores when paired with non-homorganic, non-homotypical articulations. These consonants did not participate in such contrastive sets when presented as face-on visual stimuli (see Table 4). The specific hypothesis is presented as a visibility chart, Table 7.

An adequate test of this hypothesis (given, in addition, certain controls in the stimulus materials themselves) required two simultaneously filmed tests--one providing a full-face view of the speaker comparable to that assumed for Film Test I, and the other showing a profile view of 45 degrees.

Thus, Test II consisted of two parts: a view-experimental film and a view-control film, both of which were exposed at a single presentation of test materials, with variant angle controlled by camera positions. Other technical aspects of the film (e.g., lighting) were constant for both views.

A. Alveo-Palatal Consonants

Because consonant-initial phonations involving labial articulation had already been established as visually contrastive with alveo-palatal consonants, it was necessary only that stimulus materials for this section of the test compare alveo-palatals with: (1) alveolars, (2) dentals, and (3) velars.

B. Dental Spirants

Dental spirants, on the other hand, had shown ambiguous visual relationships with both labial and alveolar articulations. A test of these consonants, then, required stimuli comparing θ- and ð- with (1) labio-dentals, (2) alveolars and (3) velars.

The comparison of dentals and alveo-palatals is covered under A-2 above.

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[11] The following quotation exemplifies this view: "...the movements of the lips for 'f' and 'v' and that of the tongue for 'th' are like traffic lights for a good lipreader." Sonotone Corporation, 1941, p. 24.

TABLE 7

POSTULATED VISIBILITY OF DIFFERENCE AMONG CONSONANT-INITIAL ALLOPHONES AS PROFILE-VIEW STIMULI*

Labial	Alveo-Palatal	Alveolar, Dental	Velar, Glottal
p-	č-	t-	k-
b-	ǰ	d-	g-
m-		n-	
		l-	
(W-)	š-	s-	h-
w-	(ž-)	z-	
r-	y-		∅-
f-		θ-	
v-		đ-	

*ž- could not be included as a syllable-initial consonant in stimuli for Film Test II since it does not occur in this position in actual lexical items of English. Voiceless W- (not relevant to this hypothesis) was tested with CC-clusters (Cf. f.n. 12).

C. Variant Articulation Type

If it is postulated that alveo-palatal consonants are visually distinct from alveolars, then there is also a possibility for visually-contrastive relations among the three articulatory types of the alveo-palatal group itself, viz., the affricates (č-ǰ), the spirants (š-ž), and the semi-vowel (y-). As an example, if *č-* is visually distinct from *t-*, and *š-* is visually distinct from *t-*, then it may reasonably be expected that *č-* and *š-* are also visually distinct from each other. Reducing it to phonetic components based on points of articulation, we may symbolize /č/ as [t + š]. By the same token, of course, if *s-* is distinctive from both *š-* and *y-*, then *y-* may be expected to be discriminated from *š-*.

Stimulus materials for the specific aspects of the view-angle hypothesis, then, also included comparisons among the three sub-units of the alveo-palatal consonant initials: (1) affricate-spirant, (2) spirant-semi-vowel, and (3) affricate-semi-vowel.

II. Differential Perceptibility of Vocalic Nuclei

The film test was also designed to determine perceptual differences among English vowels. This sub-experiment had objectives similar to those of the Pilot Study of consonant discrimination.

Because the perceptual contrastiveness of vocalic phonemes had not been established, it was necessary to maintain contextual controls in this part of the test which are comparable to those imposed in the consonant study. The principal experimental requirement, in these terms, was that vocalic stimuli be presented in *minimally-distinctive environments*.

Because we were dealing now with words rather than nonsense syllables, it was impossible to select large sets of lexical items which are minimally-distinctive in analytic terms. In order to simplify the assessment of comparative data from auditory and audio-visual control groups, the criterion of minimal analytic distinctiveness was followed insofar as possible; to complete the test sets, however, minimally-different environments were defined in terms of the homophenous units derived in the first experiment.

A. The following formula was used to select one complete minimal set: bilabial C -V- postlabial C.

B. A small number of intersecting sub-sets were based on the several variables outlined in Table 8.

TABLE 8

VOWEL CHART

Tongue-(Lip) Positions	FRONT (Extended)	CENTRAL (Extended)	BACK (Rounded)
HIGH	iy		uw
	i		u
MID	ey		ow
	ay		aw
	e	ə	
			ɔy
LOW	ä	a	ɔ

Perceptibility of the articulatory differences among the seven simple vowels and the seven diphtongs (V + SV) which comprise the vocalic nuclei of Standard Midwestern American English was tested in terms of the phonetic dimensions of the vocalic system; Table 8 classifies the 14 vowel nuclei according to the significant articulatory dimensions.

III. Differential Perceptibility of Consonant Initial Allophones in Variant Vocalic Environments

Because Pilot Study results were obtained by presenting consonant stimuli in a single phonetic environment, the visual units derived in that study were tested as consonant initials in differently-defined vocalic environments.

Perceptibility of the following Visually-Equivalent groups of analytic units (cf. Table 4) was retested in initial position preceding various vowel nuclei:

Bilabial	p-b-m
Rounded labial[12]	w- r-
Labio-dental	f-v
Dental	θ-đ
Alveolar	t-d-n-l s-z
Alveo-palatal	č-ǰ-š y-
Velar	k-g h- ∅-

These units proved to be Contrastive or Similar (i.e., non-equivalent) when presented as visual stimuli preceding a low central vowel (-a·). Section III of the present experiment was designed to provide additional environments defined by the following points along the principal dimensions of vocalic articulation (cf. Table 8, Vowel Chart):

A. High front vowel /iy/

(B. High back vowel /uw, u/
(C. Low back vowel /ɔ/

D. Mid-central vowel /ə/

IV. Differential Perceptibility of Consonant-Initial Clusters

Section IV of the present experiment was designed to test perceptual differences among English consonant phonemes in the (C)CC-position of monosyllabic words, viz., where the consonant occurs as a constituent of a syllable-initial bi-consonantal or tri-consonantal cluster.

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[12] Because the syllable-structure formulae followed in Test II allowed for initial consonant clusters, the unit W- of the pilot experiment was re-defined as an hw- cluster, and is listed in that section of the report (see Sec. IV).

Maintenance of experimental controls for this phonological variable required minimally-different sets of stimulus words, selected in terms of the formulae:

$C_1C_2V_1C_3$		plain	/ pleyn /
$C_1V_1C_3$	e.g.	pane	/ peyn /
$C_2V_1C_3$		lane	/ leyn /

The cross-cutting variable of vowel environment (cf. Sections III and V) was also controlled by selection of a number of stimulus sets with syllabic units defined by the phonetic dimensions of the several vocalic nuclei.

Each (C) C_1C_2-cluster was not compared with every other C_1C_2-cluster and with (s), C_1, and C_2 initials, but the specific paired relations tested by the formulae were selected to be representative of all relevant consonantic dimensions. The selection was also based on the homophenous unit to which the initial member of the CC-cluster belongs according to Test I results.

The 36 English CC-initial and 8 (s)CC-clusters are summarized in Table 9 --according to the classificatory order of C-initial allophones established by the hypotheses and results of the Pilot Study (cf. Table 4). Though for sake of completeness, Table 9 shows all possible initial (s)CC-combinations for the English monosyllabic word (cf. Whorf, 1949, Fig. 1), not all clusters will fit the framework set up for Film Test II; gw-, for example, occurs only in proper names (e.g., Gwen).

V. Differential Visibility of Consonant-Final Allophones

Because actualizations of English consonant phonemes in word-final position show articulatory features which differ from those characteristic of consonant-initial allophones, the patterns of phonetic difference which distinguish these phonemes in final position may have a different structure of perceptual correlates than that suggested by the pilot experiment.

One section of Film Test II, then, was devoted to examining dimensions of perceptual difference among final allophones of English consonants. A general hypothesis of these relationships, for visual conditions of reception, is summarized in Table 10.

Though stimulus selection was based in part on the results of Test I, environmentally-determined differences of articulation made it

TABLE 9

(C) CC-CLUSTERS

	Second Member									
First Member	p	m	w	r	f	t	n	l	y	k
p				(s) pr-				(s)pl-	(s) py-	
b				br-				bl-	by-	
m									my-	
f				fr-				fl-	fy-	
v									vy-	
θ			θw-	θr-						
t			tw-	(s)tr-						
d			dw-	dr-						
s	sp-	sm-	sw-		sf-	st-	sn-	sl-		sk-
š				šr-						
k			(s)kw-	(s)kr-				(s)kl-	(s)ky-	
g			gw-	gr-				gl-	gy-	
h			hw-						hy-	

necessary to re-investigate visual relationships among some of the analytic units which comprise the homophenous sets of syllable initials. Phonological variables for Section V, then, included certain dimensions of difference among consonant phonemes which proved non-significant in the visual discrimination of consonant-initial allophones.

A. Homorganic Sets

Area of articulation is the crucial dimension of visual difference among initial consonants, and Pilot Study results had demonstrated that there are no visually-perceptible cues to the analytic differences among homorganic sets of voiceless-voiced stops and continuants (e.g., p-b-m). It is possible, however, that in final position phonetic features redundant to the basic criteria of voicing and articulation type may prove available to visual observation.

Variation in length of a medial vowel, for example, is a partial function of the phonetic character of the following consonant-final. Consider the minimal set: rip, rib, rim where phonemic difference is expressed only in the final consonant position. As a function of the single phonemic difference, however, the minimal set exemplifies three phonetically-different forms (allophones) of the vocalic unit /i/. rip contains the shortest and rim the longest variety of the vowel (of the three forms given in this particular example).[13] Phonetically, a still greater difference may be attributed to the -VC portion of rim, by virtue of the length of the continuant consonant itself.

Though it was not considered likely that each of the separate gradations of vowel length (or combined -VC length) would render the differences among consonantal articulations visually perceptible to the untrained lipreader, it is quite possible that the greater length differences (e.g.,

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[13] Actually, there are at least five phonetically-determined variations in the length of simple vowel nuclei in the pre-final-consonant environments of a stressed syllable. Duration varies from short to successively-longer in a position preceding the following consonantal articulation types: (1) voiceless stop (p), (2) voiceless spirant (f), (3) voiced stop (b), (4) continuant (m), and (5) voiced spirant (v). (cf. Trager and Smith, 1951, Section 1.1 and 1.2). Because we were concerned only with homorganic sets, however, stimulus selection for Film Test II depended for the most part on varieties (1), (3), and (4)--those exemplified in the p-b-m set above.

TABLE 10

POSTULATED VISIBILITY OF DIFFERENCE AMONG CONSONANT-FINAL ALLOPHONES

ARTICULATION TYPE		AREA OF ARTICULATION				
		Labial	Dental	Alveolar	Alveo-Palatal	Velar, Glottal
Stops and Affricates	Vl.	-p		-t	-č	-k
	Vd.	-b		-d	-ǰ	-g
Continuants		-m		-n		-ŋ
				-l		
Spirants	Vl.	-f	-θ	-s	-š	
	Vd.	-v	-đ	-z	-ž	
Semi-Vowels*		-w		-r	-y	-∅

*It should be noted that although they function as components of complex vocalic nuclei (cf. Sec. II and Table 3), final -w and -y are allophones of phonemes whose initial variants are consonantic in function. For a systematic set of comparisons, then, -w and -y must be included with other consonants in a test of perception of final allophones.

Certain of the phonetic relationships to be investigated in the second test of the experimental series required that -w and -y be considered a part of the syllabic nucleus of the stimulus unit, whereas other comparisons required their treatment as final-consonant allophones.

The zero-consonant position is a device for handling this variation consistently, as well as a substitute designation for the mid-central glide which Trager and Smith phonemicize as a final h-allophone comparable to -w and -y (1951, Secs. 1.23 and 1.32). a and ə are the only simple vowels of Midwestern English which occur in the so-called h-environment in final open syllables--i.e. without vocalic dipthongization (-w, -y) or other final consonants.

those between -Vp and -Vm) are potentially-visible correlates to phonemic distinctions among final consonants. Given stimuli to test analytic contrasts deriving from the combined criteria of voice and articulation type, then, it was felt that any results differing from those of Test I should at least suggest directions for further study and, perhaps, for the development of special teaching techniques.

B. Variant Forms of the r-Phoneme

Perhaps the greatest visible difference in articulation between initial and final actualizations of English consonant phonemes is shown by the relevant allophones of /r/. The high visibility rating attained by this consonant in the pilot experiment is attributable to the lip rounding which is characteristic of word-initial r-. Even in those dialects of English which include a final -r, however, the labial feature is lacking in this position. On this basis, word-final -r was placed with the alveolar consonants for the purpose of assessing homophenous relationships among consonant finals (cf. Table 10). In terms of this reclassification, final -r was to be compared with the partially homophenous units of initial position (w-, f-v), as well as with the post-labial consonants which were visually distinctive from r- initially.

C. Relative Visibility of Final Allophones of all Consonants

Because of the nature of the conditioned variations in consonantal articulation in final position, the relative visibility of phonation postulated for final consonants (Table 10) shows greater differentiation among analytic units than that derived in tests of consonant-initial allophones (Table 4).

Including stimuli selected specifically to test perceptual relations within homorganic sets, then, and between -r and other consonants, Film Test II was designed for comparisons of all the phonemic dimensions which define analytic differences among English consonants. Stimulus materials for this section of the experiment, then, included examples of all final consonants, or of all dimensions of consonantal contrast in final position.

VI. Re-test of Inconsistent Visual Units

Section VI of the proposed experiment was devoted to a reexamination of phonological variables for which earlier testing resulted in ambiguous categories, *viz.*, the following unequally-differentiated units of visual perception (cf. Table 4):

A. (W)-w/r

B. r/f-v

C. f-v/θ-ð

A limited administration of Film Test I, under conditions which differed from those followed in the Pilot Study,[14] had indicated that experimental procedures and analytic techniques of Test II should reveal a clearer picture of the relationships among these articulatory dimensions than that afforded by the dichotomous-choice pattern utilized in earlier testing.

Adoption of these procedures, however, depended on the use of actual lexical items as stimuli. Given a phonemic transcription of stimulus materials--in the dialect of the informant appearing in the film--it was felt that conventional English orthography would be adequate, in most cases, for identifying and comparing the responses phonemically.

The selection of English vocabulary items as stimuli would also permit the construction of matrices which show the direction of perceptual confusion among the relevant phonetic dimensions. By these procedures the unequally-different categories under investigation should be eliminated or explained.

Specific reference to Pilot Study results, however, meant that stimulus materials selected to check the questionable consonant relations should include the *-a*· environment of Test I. Because not all the crucial consonants occur contrastively in this particular environment, this part of the experiment was to be supplemented by data from a second nonsense-syllable test (Film Test III, q.v.).

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[14] The test was administered to two subjects with considerable experience in structural linguistics. Their task was not to respond to the syllable pairs as "alike" or "different" (as in the pilot experiment), but to identify *per se* the consonant-initial phonemes of each syllable.

Part Three: Classification of Hypotheses

A set of specific hypotheses, derived from the above discussion of the variables for Test II, are outlined below by corresponding numbers. It should be emphasized that the various hypothetical findings concerning visual contrastiveness, similarity, and equivalence of phonemes were meant to apply only to the responses of subjects to the discrete monosyllabic utterances used as stimuli. While it was anticipated that many of the postulated relationships have much wider application, it could not be an automatic assumption.

I. View-Angle Hypothesis

One hypothesis specifying the relevance of view-angle for the visual perception of particular groups of consonant phonemes was presented in the classification of variables (see Table 7). In addition, because the entire test was filmed with a profile view of the speaker, as well as a full-face view, profile view was a cross-cutting variable for tests of all discriminations, and is referred to below wherever it is considered relevant for visual perception.

II. Differential Perceptibility of Vocalic Nuclei

It was postulated that the most important articulatory dimension for the visual perception of vowels and diphthongs (see Table 8) is the factor of lip position, i.e., whether the lips are extended or rounded. Thus, the vocalic nuclei of English monosyllabic words presented in isolation may be divided immediately into two-visually contrastive groups (the classification includes diphthongs on the basis of lip position of the final element):

Extended: iy i ey e ä ə a ɔy

Rounded: aw uw u ow ɔ

This grouping corresponds to a grouping based on tongue position, since front and central vowels are extended, while back vowels are rounded.

Further discrimination is possible on the basis of the changes of lip and tongue position during articulation, i.e., whether simple vowels or diphthongs are involved. The diphthongs, in turn, may be subdivided according to the amount of movement involved in the changes of position of lips (and of the tongue, along the front-central-back continuum):

		TONGUE POSITION (Front to Back)	
		Changed	Unchanged
LIP POSITION	Changed	aw ɔy	
	Unchanged	ay	iy ey uw ow

The diphthongs -aw- (extended to rounded; central to back) and -ɔy- (rounded to extended; back to front) show the greatest amount of positional change in the above terms; they also demonstrate changes in tongue position from low to high, or high to higher, along the latter dimension. It was postulated, therefore, that -aw- and -ɔy- would be visually contrastive with all other vocalic nuclei (and with each other), while the remaining diphthongs would be visually similar to the simple vowels.

Primarily on the basis of lip position, four visually-contrastive units of vocalic articulation were distinguished hypothetically;

(i) Extended: iy i ey e ä ay ə a

(ii) Rounded: uw u ow ɔ

(iii) Extended to rounded: aw

(iv) Rounded to extended: ɔy

Within the groups containing more than one analytic member (i) and (ii), discrimination may be made in terms of tongue position from high to low. This perceptual distinction is relatively less precise, however, than that based on lip position, since it is not as visible, and since it does not provide two clear-cut groupings. It was postulated, therefore, that overlapping sets of visually-similar vowel nuclei would be found in test responses.

More specifically, it was assumed that vocalic nuclei in Groups (i) and (ii) would be confused with vowels adjacent to them in tongue height, as well as with vowels adjacent to their immediate neighbors along this continuum. While it was expected that the number of correct responses to a given vocalic stimulus of these categories might not equal the total number of near-missed responses, the number of correct responses should be greater than that for any specific incorrect response. For example, responses to -iy- would include perceptions as -iy-, -i-, and -ey- on a diminishing scale; in turn, responses to -i-, besides correct perceptions, would include -iy- and -ey- and, less extensively, -e-. It was doubtful, of course, that such a neat picture would emerge for every vocalic nucleus, either for range or degree of confusion. For the non-reciprocal relationships between front and central vowels, adjacency was viewed in horizontal as well as vertical terms, and a greater range of confusion was postulated, comparable to that for -ay-.

A schematic representation in the form of a confusion matrix (Table 11) indicates the picture of results which was postulated for responses to the discrete items of the test. It should be emphasized again that such an overall comparison depends on the presentation of the several vocalic nuclei in a constant phonetic environment, since it is possible that certain final consonants (e.g., -r and nonlabial continuants -n, -l, and -ŋ) may be partially confused with vowel nuclei, while other final consonants (including -∅) may also have an effect on the perception of the preceding vowels.

III. Consonant Initial Allophones in Variant Vocalic Environments

The classification of consonant-initial allophones into contrastive, similar, and equivalent sets on the basis of data from Film Test I (see Table 4) required checking in terms of different vocalic environments for the initial consonants. Since the environment presented in the former test was held constant by use of the low central vowel -a·, groups derived from the earlier experiment were to be presented in Test II with other vocalic nuclei. These were selected to provide a range of environments, e.g., high front vowel -iy, back vowels -uw-, -u, and -ɔ, and mid-central vowel -ə. Though this procedure is experimentally and analytically desirable, it was postulated that alteration of vocalic environments would have no significant effect on the visually-equivalent units already established.

IV. Differential Perceptibility of Consonant-Initial Clusters

A consideration of the visual perceptibility of the initial clusters found in monosyllabic words required an examination of the relationships between individual constituents before any hypotheses of relative ease or difficulty of perception could be formulated. Since the relative visibility of initial consonants had been tentatively determined (see Table 4), and was to be rechecked in different vocalic environments in the present test, it was a logical next step to examine the effect of a following consonant on an initial consonant. After investigating this relationship, the question

TABLE 11

POSTULATED VISUAL CONFUSIONS AMONG VOCALIC NUCLEI

RESPONSE

STIMULUS

	iy	i	ey	e	ä	ay	ə	a	ɔy	aw	uw	u	ow	ɔ
iy	+	+	+			+								
i	+	+	+	+		+								
ey	+	+	+	+	+	+								
e		+	+	+	+	+								
ä			+	+	+	+								
ay	+	+	+	+	+	+								
ə	+	+	+	+	+	+	+	+						
a		+	+	+	+	+	+	+						
ɔy									+					
aw										+				
uw											+	+	+	
u											+	+	+	+
ow											+	+	+	+
ɔ												+	+	+

+ = Postulated response

Double lines separate visually contrastive groups of the influence of the first consonant on the perception of the second could be considered. Only then could the relative visibility of the clusters per se, in comparison with single consonant initials be considered.

Initial Consonants

There are 13 consonants in English which take the first position in initial clusters (p, b, m, f, v, t, d, θ, s, š, k, g, and h). These consonants occur before a class of four second-position constituents (w, r, y, and l). This distribution is tabulated in the cluster chart (Table 9) which indicates the specific combinations occurring. In addition to -w and -l, s- may also precede six other consonants (-p, -m, -f, -t, -n, and -k), any p- or k- cluster, or tr-. Because of the special nature of these s-clusters, they are considered separately below.

For the group of clusters discussed above, it was postulated that the presence of -w, -r, -l, and -y would have no effect on the perception of the preceding consonant initial. In other words, visually-contrastive units established in the earlier test would not be disturbed by the occurrence of 13 of the consonants as initial members of clusters, nor would the perceptibility of these 13 consonants be aided or hindered by this variation in environment. This postulation was in close agreement with the hypothesis concerning the effect of variant vocalic environment on perception of initial consonants, and it may be justified logically by the fact that two of the consonants in question are semi-vowels (-w and -y), while the other two (-r and -l) are liquids.

Second-Position Consonants

Omitting consonants which appear only after s-, the perceptibility of -w, -r, -l and -y as the second members of clusters may now be considered. Because -r is not characterized by the lip rounding of initial r-, it was assumed that it would not enter into a visually-contrastive group with -w (as it did initially), but that it would probably demonstrate visual similarity with members of the large group of non-labial consonants. It was felt, however, that the semi-vowels and -l would probably retain their respective relationships with other consonants. It was postulated, therefore, that perception of the four consonants which may fill the second position in more than one cluster would be equivalent to their perception in final position (see Table 10).

Clusters with s-

This category was based on the fact that six consonants may follow no other consonant than s- in initial clusters, and further, that the only tri-consonantal initial clusters in English begin with s-. The permissible combinations are summarized in Table 9.

It was postulated (Sec. IV-A) that s- before -l and -w (as with the other initial consonants) would be neither easier nor harder to perceive than when it appears alone initially. The same assumption was made for s- before -t, -n, and -k. With regard to the s-clusters with bilabial or labio-dental second members, it is possible that any visible lip movements before the labial closure may be taken as s-, since this is the only phoneme which can appear in this position in a monosyllabic word. Because no specific effects of redundancy were hypothesized for the cumulatively-limited possibilities of English structure, however, it was postulated, in the form of a null hypothesis, that s- before other consonants would not be visually contrastive with other non-labial consonants.

Turning to a consideration of the second members of bi-consonantal s-clusters (-p, -m, -w, -f, -n, -l, and -k), there appeared to be no reason for assuming differences in perceptibility other than those which had been discovered or postulated for their respective initial and final allophones. The relevant allophones of these particular consonants show, in some cases, greater resemblances to the initial allophones, and in other cases, to the finals. However, since none of the phonetic differences involved indicates any changes in degree of visual perceptibility, and since the same conclusions were reached with regard to the initial and final allophones of these eight consonants, it was postulated that they would fall into the same visually similar and contrastive groups as before (p-m, w, f, t-d-n, k).

The additional complication of the tri-consonantal clusters (only five of which appear in common monosyllabic nouns: spr-, spl-, str-, skw-, and skr-) were dealt with in terms of the corresponding bi-consonantal clusters (pr-, pl-, tr-, kw-, and kr-). Thus, consideration of -p-, -t-, and -k- may be referred to discussions both of initial p-, t-, and k-, and of the second members of clusters following s-. Remarks about -w, -r and -l as second members of clusters again apply.

Clusters as Units

Implications of the above assumptions about the relative visibility of individual constituents of clusters may be summarized as hypotheses of perceptibility for clusters as units.

It was postulated that if both members of a -w, -r, -l, or -y group cluster are characterized by some degree of labial involvement, the cluster itself may be correctly perceived--within the limits of the respective homophene classes. It should be noted, however, that this restriction applied only to clusters with -y (py-, my-, fy-, vy-), which are limited in distribution to positions before -uw in a relatively small number of words, and these in turn, enter into only a few minimal sets. The redundancy which results from the limitation of structural possibilities, then, was considered a factor in perceptibility, especially since lip extension for y- did not prove contrastive in the earlier test.

For the remaining clusters, it was postulated that if only one consonant has noticeable lip movement in articulation--regardless of its position in the cluster--the cluster itself will be visually similar to the respective labial consonant (or its homophenes) appearing alone, and with any clusters of the same category, with the same labial consonant (or its homophenes). There is some justification for this in the visual equivalence of W- and w- as shown in Test I (although both were visually contrastive with h-). Since W- was now to be interpreted as hw-, the visual equivalence between hw- and w- indicated a high probability for the "masking" of a non-labial consonant by a labial articulation. It was felt that if this hypothesis is valid, an extremely large number of homophenous consonantal articulations would result.

For clusters composed of two non-labial constituents, difficulties of perception and discrimination appear so great that no hypotheses were formulated. It was not expected, however, that perception would be completely random, and it was hoped that subsequent analysis would provide leads to other possible means of discrimination.

For clusters beginning with s-, it was likewise postulated that s-clusters which include consonants of labial articulation (sp-, spl-, spr-, sm-, sf-, sw-, skw-) would be visually similar to the respective labial constituents appearing alone and in other clusters (see preceding paragraph). This hypothesis corresponds to the null hypothesis of the perceptibility of initial s- in clusters. For this reason, it should be emphasized that contradictory results in this area were not considered unlikely. Remarks made in the preceding paragraph apply to s-clusters containing no labial consonants and, with even greater strength, to the remaining tri-consonantal clusters (skl- and skr-).

V. Differential Visibility of Consonant-Final Allophones

The articulatory differences between initial and final allophones of various consonant phonemes have been discussed in the classification of variables (Part Two), and a general hypothesis of the relative visibility of difference among final allophones has been included as Table 10. This chart may be compared with Table 4, which summarizes earlier test results on consonant-initial allophones. In addition, comparison should be made with visibility of difference which was postulated for certain groups of consonants under profile-view conditions (Table 7). The same differences in differential visibility were postulated for the final and initial allophones of the relevant phonemes, the alveo-palatal and dental consonants.

VI. Re-Test of Inconsistent Visual Units

No specific hypotheses were formulated for examining the unequally-differentiated units derived in earlier testing: A. (W) -w/r; B. r/f-v; C. f-v/θ-ð. Nevertheless, stimulus materials consisting of minimal pairs for checking these discriminations were included and, as was mentioned earlier, it was hoped that the analytic procedures possible under experimental conditions for the new test would either eliminate or explain the unequally-different categories.

It may be noted, by reference to Table 7, that under profile-view conditions, it was postulated that while Group A(w-r) remains ambiguous, Groups B and C would form units which are visually contrastive; this definition eliminates the confusion between r- and f-v, on the one hand, and between f-v and θ-ð on the other. Group C, in fact, was to receive a specific check in the analysis of the view-angle hypothesis. It was also postulated that, regardless of view, the ambiguities noted initially in Groups A and B will not be found finally, because of the differences in articulation for -r as compared with r-. New ambiguities are not unlikely, however, in the tentative position granted -r in Table 10.

Part Four: Classification of Stimulus Materials

To clarify the phonetic relationships under consideration, stimulus units are given both in conventional English spelling and in phonemic transcription.

I. VIEW-ANGLE HYPOTHESIS (specific)

A. Alveo-Palatal Comparisons

1) Alveolars

shoe - zoo	/šuw - zuw/
yawn - dawn	/yɔn - dɔn/
job - shop - top	/ǰab - šap - tap/
chin - gin - shin - tin	/čin - ǰin - šin - tin/

2) Dentals

chum - thumb - (sum)	/čəm - θəm - səm/
chief - thief - (leaf)	/čiyf - θiyf - liyf/
yawn - thought	/yɔn - θɔt/

3) Velars

job - shop - cop	/ǰab - šap - kap/
cheer - year - gear - ear	/čir - yir - gir - ir/
shawl - yawn - call - hall	/šɔl - yɔn - kɔl - hɔl/

B. Dental Comparisons

1) Labials

thought - fawn	/θɔt - fɔn/
thing - fig - fin	/θiŋ - fig - fin/

I-B-2) Alveolars

thought - dawn - song	/θɔt - dɔn - sɔŋ/
thug - (rug) - tug	/θəg - rəg - təg/

3) Velars

thing - king	/θiŋ - kiŋ/

C. Comparison of Articulatory Type

1) Affricate-Spirant

chin - shin	/čin - šin/
job - shop	/ǰab - šap/

2) Spirant--semi-vowel

shawl - yawn	/šɔl - yɔn/
shoe - you	/šuw - yuw/

3) Affricate--Semi-vowel

cheer - year	/čir - yir/

II DIFFERENTIAL PERCEPTIBILITY OF VOCALIC NUCLEI

A. Minimal Set: labial - V - postlabial

beet	/biyt/			boot	/buwt/
bit	/bit/	bite	/bayt/	book	/buk/
bait	/beyt/	bus	/bəs/	boat	/bowt/
bet	/bet/	pot	/pat/	boy	/bɔy∅/
bat	/bät/	bout	/bawt/	boss	/bɔs/

II-B. Minimally Intersecting Sets

1) fVt

feed	/fiyd/			fool	/fuwl/
fin	/fin/	fight	/fayt/	foot	/fut/
fate	/feyt/	fudge	/fəǰ/	phone	/fown/
--		--		voice	/vɔys/
--		--		fawn	/fɔn/

2) tVp

team	/tiym/			tube	/tuwb/
--		type	/tayp/	--	
tape	/teyp/	sum	/səm/	--	
--		top	/tap/	--	
tab	/täb/	--		--	

3) hVt

--		--		hooch	/huwč/
hill	/hil/	--		hood	/hud/
--		--		--	
head	/hed/	--		oil	/ɔyl/
--		owl	/awl/	hall	/hɔl/

III. CONSONANT-INITIAL ALLOPHONES IN VARIANT VOCALIC ENVIRONMENT

A. High front vowel /iy/

beet - weed - reed - feed - seed /biyt - wiyd - riyd - fiyd - siyd/

-- -- reef - thief - leaf /-- -- riyf - θiyf - liyf/

III-B. High back vowel /uw, u/

pool - rule - fool - tool	/puwl - ruwl - fuwl - tuwl/
book - wool	/buk - wul/

C. Low back vowel /ɔ/

boss-walk-fog-thought-talk-chalk	/bɔs - wɔk - fɔg - θɔt - tɔk - čɔk/

D. Mid-central vowel /ə/

bus - rug - fudge - thug - judge	/bəs - rəg - fəǰ - θəg - ǰəǰ/
-- -- -- -thumb-sum-chum-gum	/θəm - səm - čəm - gəm/

IV. DIFFERENTIAL PERCEPTIBILITY OF CONSONANT -INITIAL CLUSTERS

A. Comparison of C-Initial Clusters with the C-Initial Allophones of their Constituents: C_1C_2-C_1-C_2

1)	prose - pose - rose	/prowz - powz - rowz/
2)	blight - bite - light	/blayt - bayt - layt/
3)	butte - boot - you	/byuwt - buwt - yuw/
4)	freight - fate - rain	/freyt - feyt - reyn/
5)	flight - fight - light	/flayt - fayt - layt/
6)	fuel - fool - you	/fyuwl - fuwl - yuw/
7)	(θw - θ - w)	
8)	throng - thong - wrong	/θrɔŋ - θɔŋ - rɔŋ/
9)	twitch - ditch - witch	/twič - dič - wič/
10)	train - date - rain	/treyn - deyt - reyn/
11)	suite - seed - weed	/swiyt - siyd - wiyd/

IV-A-12)	slide - light - sign	/slayd - layt - sayn/
13)	shred - shed - wreck	/šred - šed - rek/
14)	quake - cake - wake	/kweyk - keyk - weyk/
15)	grain - cane - rain	/greyn - keyn - reyn/
16)	click - kick - lick	/klik - kik - lik/
17)	cue - goose - you	/kyuw - guws - yuw/
18)	hue - hooch - you	/hyuw - huwč - yuw/

B. Comparison of C-Initial Allophones in Variant C_2 Environments

1) p-pr-pl-py-

-- -broom - bloom - --	-- - /bruwm - bluwm/
boot - brute - -- -butte	/buwt - bruwt - -- - byuwt/

2) f-fr-fl-

fight - fright - flight	/fayt - frayt - flayt/

3) (θ-θw-θr-)

4) t-tw-tr-

ditch - twitch - trick	/dič - twič - trik/

5) k-kw-kr-kl-

gas - quack - grass - glass	/ga̎s - kwa̎k - gra̎s - gla̎s/

6) (h-hw-hy-)

C. Comparison of C_2 Allophones in Variant C_1 Environments

1) w-tw-sw-kw-hw-

weed - tweed - suite - queen - wheat

/wiyd - twiyd - swiyt - kwiyn - hwiyt/

IV-C-2) r-pr-fr-θr-tr-šr-kr-

rain - -- - freight - -- train - -- - grain

/reyn - - freyt - -- treyn - -- - greyn/

wreck - bread - -- -thread - -- - shred - --

/rek - bred - -- -θred - -- - šred - --/

3) l-pl-fl-sl-kl-

light - blight - flight - -- - slide - -- - glide

/layt - blayt - flayt - -- - slayd - -- - glayd/

4) y-py-fy-ky-hy-

you - mule - fuel - cue - hue

/yuw - myuwl - fyuwl - kyuw - hyuw/

D. Comparisons of s-Clusters

1. sC-Clusters

a. Comparison of sC_2-Clusters with s- and C_2- initials: (sC_2-s-C_2)

1)	speed - seed - beet	/spiyd - siyd - biyt /
2)	suite - seed - weed	/swiyt - siyd - wiyd/
3)	sphere - seer - fear - ear	/ sfir - sir - fir - ir/
4)	steam - seam - team	/stiym - siym - tiym/
	slide - sign - light	/slayd - sayn - layt/
5)	ski - seed - key	/skiy - siyd - kiy/

IV.-D-1-b. Comparison of s-initials in variant C_2 environments

1) seed - speed - suite - -- - sneeze - ski
/siyd - spiyd - swiyt - -- - sniyz - skiy/

2) seer - smear - -- - sphere - -- - --
/sir - smir - -- - sfir - -- - --/

3) -- - spool - -- - -- - stool - school
/-- - spuwl - -- - -- - stuwl - skuwl/

2. Comparison of sC_2C_3-Clusters with C_2C_3-, C_3-, sC_2-, s-, and C_2-Initials

spr-

spree - breed - reed - speed - seed - beet
/spriy - briyd - riyd - spiyd - siyd - biyt/

spl-

splice - blight - light - spine - sign - pile - eye - slide
/splays - blayt - layt - spayn - sayn - payl - ay - slayd/

str-

stream - dream - ream - steam - seam - team
/striym - driym - riym - stiym - siym - tiym/

skw-

squeeze - queen - weed - ski - seed - key - suite
/skwiyz - kwiyn - wiyd - skiy - siyd - kiy - swiyt/

skr

scream - cream - ream - scheme - seam

/skriym - kriym - riym - skiym - siym/

V. DIFFERENTIAL VISIBILITY OF CONSONANT-FINAL ALLOPHONES

A. Homorganic Sets

1) -p-b-m

nap - tab - lamb /na̋p - ta̋b - la̋m/

soup - tube - loom /suwp - tuwb - luwm/

2) -t-d-n-l

bit - bid - bin - bill /bit - bid - bin - bil/

coat - code - cone - coal /kowt - kowd - kown - kowl/

3) -k-g-n

wick - wig - wing /wik - wig - wiŋ/

talk - dog - song /tɔk - dɔg - sɔŋ/

B. Variant Forms of the r-Phoneme (-r/-w-f-alv)

car - cow - -- - cot /kar - kaw - -- - kat/

door - dough - loaf - load /dɔr - dow - lowf - lowd/

deer - -- - sieve - tin /dir - -- - siv - tin/

V-C. Dimensions of Difference among other Final Consonants

1) -p-f-θ-t-č-k

ream - reef - wreath - reed
/riym - riyf - riyθ - riyd/

room - roof - tooth - root - rouge
/ruwm - ruwf - tuwθ - ruwt - ruwž/

2) -t-s-z

bite - price - prize
/bayt - prays - prayz/

3) -d-s-z-č-ǰ-š

seed - niece - sneeze - leech - siege - leash
/siyd - niys - sniyz - liyč - siyǰ - liyš/

VI. RE-TEST OF INCONSISTENT VISUAL UNITS

A. (W)-w/r

weed - reed	/wiyd - riyd/
wing - ring	/wiŋ - riŋ/
witch - ridge	/wič - riǰ/

B. r/f-v

reed - feed	/riyd - fiyd/
rule - fool	/ruwl - fuwl/

VI-C. f-v-θ-

fin - fig - thing	/fin - fig - θiŋ/
fog - thong	/fɔg - θɔŋ/
fawn - thought	/fɔn - θɔt/

RESULTS

The various forms of Film Test II were administered to 19 groups of university students in the Los Angeles and Berkeley areas. In addition to these students, the subjects included two groups, totaling 13 and 19 respectively, at the John Tracy Clinic where the full-face and profile visual forms of the test were shown.

The total of 428 sets of responses obtained were distributed according to the following experimental and control conditions:

	N
Visual, full-face view	106
Visual, profile view	113
TOTAL, Experimental subjects	219
Audio-visual, full-face view	56
Audio-visual, profile view	53
Auditory	1 00
TOTAL, Control subjects	209

A sample cover page for the answer sheets used in administering the visual forms of the test is included as Appendix F. While the cover pages for the audio-visual and auditory forms of the test had a different set of instructions, the personal data requested was the same. A summary of this information is included below:

	SEX		AGE	NATIVE LG.		HEARING		VISION	
GROUPS	M	F	Mean	Eng.	Other	Normal	H-H	Normal	Corrected
Visual (219)	55	164	25.9	211	8	213	6	133	86
Audio-visual (109)	60	49	24.2	102	7	106	3	79	30
Auditory (100)	54	46	26.0	98	2	93	7	68	32
TOTAL	169	259	25.1	411	17	412	16	280	148

The discussion which follows will be limited primarily to the results obtained from the 219 normal hearing subjects who took the visual forms of the test. Auditory data are summarized, however, in the confusion matrices reproduced as Tables 21 and 26. Although in terms of the assumptions underlying use of the theoretical model, the focus of interest in this research program has been on responses elicited from normal hearing speakers of English, the various visual forms of the test were administered also to congenitally-deaf students at the California School for the Deaf, Riverside. Results of this testing are presented in Tables 19-20, 24-25, and 28-29.

For all groups, the various responses to each of the 198 stimulus words in the test were tallied, transcribed phonemically, and then combined on data sheets (see Appendix H). These sheets did not include the specific words given as responses, but rather provide for a phonemic breakdown of all responses into initial consonants (including consonant clusters), medial vowels or vocalic nuclei, and final consonants. In addition, the sheets have spaces to indicate the number of usable responses, the number of rejected responses, and the total number of different words guessed.

The greatest number of rejected responses were simply omissions on the part of the subjects, but polysyllabic responses and ambiguous spellings (e.g. 'tear') were also included, since they could not be counted in the analysis. The so-called rejects were broken down according to these categories and the total number of different words given as responses was also tallied.

The range in usable responses was 44-100% for the full-face view, 46-100% for the profile view (for each view both the highest and lowest responses were to the same lexical items). The mean response for both views was 88%. Test results will now be discussed according to certain of the more important hypotheses listed in the experimental design.

I. VIEW-ANGLE HYPOTHESIS

Some indication has been given that significant differences were not discovered between the results of the full-face film and those of the profile film. It should be emphasized that "profile" here has reference to a 45 degree angle, not a complete side view. Not only were the range and mean for usable responses almost identical for both views, but differences in general were not great. For the profile film, 96 of the 198 items had a higher frequency; and 17 words had identical frequencies for the two views. This is, of course, only a rough measure, since these figures do not have reference to correct responses. Nevertheless, they agree quite strikingly with an independent investigation of the importance of facial view for lipreading.[15]

The view-angle hypothesis formulated for testing by Film Test II, however, had specific reference to certain groups of consonants which were confused visually in Film Test I (see Table 4). As summarized in Table 7, it was hypothesized that the alveo-palatal consonants (č, ǰ, š, y) and the dental spirants (θ, đ) would be visually contrastive with dental, alveolar and velar consonants under profile view conditions. Section I of the Classification of Stimulus Materials shows the specific pairs of words for which responses were to be compared; some of these comparisons will be presented below in the form of simplified confusion matrices.

In Table 12, response frequencies are presented for the initial consonants of groups of minimally-distinctive test items. Each group contains at least one word beginning with an alveopalatal consonant, although other comparisons may be found in the table as well. Responses have been grouped according to the place of articulation for the various groups of consonants for simplicity of presentation, so that a high frequency within the proper group does not necessarily mean a high frequency of correct perception. Consonant clusters have been grouped with single consonants according to the group to which the first member belongs, except for clusters preceded by s- which have been arbitrarily assigned to the group of the second member. Response percentages given refer to the number of usable responses, not to the possible totals of 106 and 113 for the full-face and profile views, respectively.

Examination of Table 12 indicates that the alveo-palatal affricates and spirants (č, ǰ, š) appear to make up a visually-contrastive group, under both full-face and profile-view conditions, when compared with the other groups of consonants mentioned. In no case does the correct perception of

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[15] An experiment was conducted in the Speech Department, University of California, Los Angeles, in which subjects practiced lipreading through closed circuit television without sound. The material, unlike Film Test II, consisted of sentences, and three, rather than two, views were used. Mean scores were as follows: complete profile: .433; full-face: .589; 45 degree angle: .615. These are correct responses, but details of scoring were not given, nor was it stated whether the difference between the full-face and 45 degree angle was statistically significant (Larr, 1959).

TABLE 12

CONFUSION MATRIX: ALVEOPALATAL COMPARISONS

Item No.	Word	Response Frequencies* % Dentals	Alveolars	Alveo-Palatals	Velars	Other
53.	SHOE	1	17	79		2
	/šuw/		21	75	2	2
50.	zoo		48	35	15	2
	/zuw/		39	48	11	2
142.	YAWN	1	63	9	25	2
	/yɔn/		69	8	22	1
98.	thought	96	3			1
	/θɔt/	98	2			
154.	dawn	1	42	54	3	
	/dɔn/	1	45	52	2	
7.	CHIEF		10	79	11	1
	/čiyf/		12	82	6	
179.	thief	71	19	2	7	1
	/θiyf/	77	20	2	1	
195.	leaf	14	39		47	
	/liyf/	19	46	2	31	2
194.	JOB		10	89	1	
	/ǰab/		16	82	2	
151.	SHOP		7	93		
	/šap/		6	93	1	
35.	top		93		7	
	/tap/		93	4	3	
159.	cop		10	1	89	
	/kap/		10	1	89	

* The upper row of figures for each test item refers to the full-face view, the lower row to the profile view.

the alveopalatal group drop below 75% (shoe) and in one case it is 93% (shop). It will be noted, however, that alveolar consonants are frequently seen as alveopalatals, and in one case (dawn), a greater percentage of alveopalatal responses were given than alveolar ones. Further, when alveopalatals are not correctly identified by group, the incorrect responses are mostly alveolar ones. There are no significant confusions of alveopalatals with dentals, and in only one case (chief) do velar responses go above 10%.

While the semivowel y- was grouped with the other alveopalatal consonants here, it obviously does not join with them in forming a contrastive group. Though it is not evident in Table 12, the other alveopalatals were seldom perceived as y-, and in turn, the small number of times that y- in yawn was perceived as an alveopalatal were almost all correct perceptions of y- itself. The majority of responses to y- in yawn were alveolar ones; on the other hand, dawn had fewer alveolar responses than alveopalatal ones, but d- was never perceived as y-.

The dental spirants proved to be even more easily perceived than the alveopalatal ones, and again, no significant differences with regard to view were noted. No separate table is given here since the range of correct responses to the initial voiceless dental spirant (θ) may be found on Table 12: 71% for thief and 98% for thought. The voiceless member of the dental spirant pair, (θ-ð) was the only one tested; no monosyllabic noun begins with ð-. Not only does θ- consistently show a high degree of correct perception by articulatory group (including words other than nouns beginning with ð- which were guessed, despite the fact that the subjects were told all test items were nouns), but only one other phoneme, l-, an alveolar, is perceived as a dental spirant with any frequency (see leaf in Table 12). In the items picked for comparison with the labiodental spirants (f-v), neither f- nor θ- dropped below 90% correct perceptions with regard to the proper group.

The final specific comparisons in the original view-angle hypothesis concerned the possibility of making distinctions within the alveopalatal group between the affricates (č-ǰ), the spirants (š-ž), and the semivowel (y-). The fact that y- is not confused with the other alveopalatals, nor they with it, has been discussed above. Beyond this, test results do not indicate any possibility of distinguishing between the affricates and spirants under either view.

Since the specific postulates for improved visual perception of certain initial consonants with a profile view of the speaker proved to be true for either view, the differences between Test I results (see Table 4) and those just given for Test II must be a function of other factors. An attempt was made, however, to see whether any significant differences between the two views could be found. All instances of single initial consonants in the test were grouped and overall correct response percentages were derived. In this case, correct perception refers to the individual phoneme, without regard to articulatory group, and responses of consonant clusters containing the consonant in question were not counted as correct. The results of this check are summarized in Table 13. These figures cannot be considered to represent general probabilities for correct perception, since some initial consonants were presented only once or a few times, but the probabilities for the two views can be considered the same.

The information in this table demonstrates again that significant differences were not found between the two views: of the 21 initial consonants represented, 9 have better response percentages with a full-face view, and 10 with a profile view, but no pattern emerges which might indicate that one type or position of articulation benefits from either view. A similar test was run on the vocalic nuclei and again only random differences appear. From this, it would seem that either a full-face or a 45 degree profile angle is equally good for lipreading purposes.[16]

Correct and modal C-V-C responses to the 198 words of Test II--as full-face and profile-view visual stimuli--are tabulated in Appendices I and J of this report.

II. PERCEPTIBILITY OF VOCALIC NUCLEI

It was postulated that the most important articulatory dimension for the visual perceptibility of vocalic nuclei would be the factor of lip positio in other words, whether the lips are extended or rounded. Further, lip position changes in the production of two English diphthongs, in one case (aw) from extended to rounded and in the other (ɔy) from rounded to extended. On the basis of these facts, four groups of vocalic nuclei were distinguished hypothetically, manifesting internal confusions when a group contained more than one member, but contrastive insofar as the group as a whole was concerned. This overall hypothesis was summarized in Table 11.

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[16] After the profile film was shown to a group at the John Tracy Clinic, a tutor of the deaf was asked for her opinion of the profile view; she replied that she had not been aware that other than a full-face view had been used.

TABLE 13

PERCEPTION OF INITIAL CONSONANTS WITH DIFFERENT VIEW-ANGLE

Phoneme	Number of Test Items	Correct Response Frequencies %	
		Full-Face	Profile
p-	4	42	40
b-	16	52	51
w-	8	71	72
r-	16	49	52
f-	12	78	79
v-	1	15	14
θ-	6	63	74*
t-	11	14	16
d-	7	12	15
n-	2	4	4
l-	9	45	46
s-	9	38	36
z-	1	1	0
č-	5	43	40
ǰ-	3	29	22
š-	5	41	44
y-	3	28	21
k-	14	24	26
g-	4	1	2
h-	5	56	56
∅-	4	27	22

*The difference of 11 here is significant at the 5% level; however, the combined percentages for the voiceless-voiced pair of dental spirants (θ-đ) are 90 and 89, respectively, and it could not reasonably be postulated that the distinction between voiceless and voiced consonants could be made under either view.

Four minimal (or nearly minimal) sets of test items were included to test this hypothesis: a complete set with an initial bilabial consonant and a final postlabial consonant, and three partial sets with an initial labiodental and a final postlabial, an initial alveolar and a final bilabial, and an initial glottal and final alveolar. (see Experimental Design, Sec. II, Classification of Variables). A complete confusion matrix for the bilabial initial and postlabial final is presented as Table 14, utilizing data from the full-face view responses, and presented in the same form as Table 11 for easier comparison with the hypothesis.

While the internal confusions within groups i and ii do not follow the neat pattern hypothesized, the groups appear in general to be contrastive, with one possible exception. There is a significant number of central extended vowel responses to back rounded vowel stimuli, although a lower percentage was found with the full-face view. It will be noted, however, that even though the groups contrast with each other, the internal confusions are sometimes considerable, and correct responses to individual vowel nuclei are sometimes very low.

This is borne out also by a comparison of correct responses in the above minimal set with those for the partial sets, using full-face data. Table 15 presents this information, listing the percentage of correct identifications of the various vowel nuclei. It is readily apparent that the range for most of them is considerable; most striking, perhaps, is -ɔy-, which drops to 17%, so that it cannot be considered contrastive under all conditions.

Unfortunately, because three of the minimal sets are incomplete it is impossible to say whether one of these consonant environments is better for the visual perception of vowels, or whether such factors as word frequency and expectancy are operating here. In any case, it is apparent that the visual perception of English vocalic nuclei must be dependent on other factors than visible facial movements resulting from lip and tongue movements during articulation. When the combined correct responses for all vocalic nuclei in test items were compiled in a check on the profile hypothesis, the same extreme ranges of correct response were encountered (and no consistent difference was found between the two views).

Because American dialects of English are characterized by considerable vocalic variation, it is doubtful whether a picture of visual perception of English vocalic nuclei as clear as that emerging for the consonants is possible.

TABLE 14

CONFUSION MATRIX: VOCALIC NUCLEI*

Test Items	Response frequencies %													
	iy	i	ey	e	ä	ay	ə	a	ɔy	aw	uw	u	ow	ɔ
biyt	73	23	1	1	2									
bit	46	20	3	7	2	1	19					1		
beyt	3	5	32	13	36	10	1						1	
bet	1	2	29	7	42	16	2						1	
bät			2		79	9	1	7	2	2				
bayt	4	3	24	11	10	28	13	4			1	1		
bəs	10	3	22	6	4	21	32	2						
pat			1		12	9	3	65						10
bɔy			1		1				93			2	2	1
bawt										97				3
buwt	5	3					9			7	41	29	3	2
buk			1		1	1	18	2	6		4	63		4
bowt							1				11	14	71	2
bɔs	1			2	2		1	32	3				2	56

*Lines separate visually contrastive groups according to the hypothesis (cf. Table 11).

TABLE 15

CORRECT PERCEPTION OF VOCALIC NUCLEI IN DIFFERENT ENVIRONMENTS

Vocalic nuclei	Correct Response %			
	Bilabial-Postlabial	Labiodental-Postlabial	Alveolar-bilabial	Glottal-Alveolar
iy	73	72	47	--
i	20	32	--	55
ey	32	45	1	--
e	7	--	--	10
a̎	79	--	68	--
ay	28	71	20	--
ə	32	13	34	--
a	65	--	92	--
aw	97	--	--	97
ɔy	93	17	--	49
uw	41	93	96	69
u	63	--	--	49
ow	71	53	--	--
ɔ	56	84	--	83

III. INITIAL CONSONANTS IN VARIANT VOCALIC ENVIRONMENTS

The classification of English initial consonants derived from the results of Test I was based entirely on the appearance of these consonants before the low central vowel -a·. In order to see whether this classification was in any way dependent on the selection of this vowel for the nonsense syllables of Test I, various minimal sets were included among the items for Test II in which representatives of the units established from earlier results preceded different vocalic nuclei.

It was postulated, however, that variation of the vowel would have no significant effect on the units already established. With one important qualification, this hypothesis proved to be correct. The qualification refers to the visual contrastiveness already established by Test II for the alveopalatals and dentals (see the discussion of the view-angle hypothesis above). The bilabials, labiodentals, and dentals, together with the rounded labials (w-r), achieved high correct response percentages with regard to their respective groups before -iy-, -uw-, - ɔ -, and - ɵ -. Internally, the usual random confusions were found, such as between p-, b-, and m-, or f- and v-.

Similarly, the alveopalatals also had almost identical correct scores of more than 80% before - ɔ - and - ə- the only vowels before which they were tested; again this is high enough to assume visual contrastiveness. Three alveolar consonants were also tested in these sets, and here the correct response percentages fell very low. While 94% of the responses to s- were alveolars for the test item seed, only 39% of the responses to 1- in leaf were alveolars. Responses to t- in tool and talk were 36% and 35% for alveolars, respectively. All figures given here are from the full-face view results, but profile view scores were similar. For these particular items nearly half the responses were alveopalatal ones, showing the unreciprocal confusion discussed earlier. However, the wide variation in correct response for initial alveolar consonants does not seem to be consistently influenced by the vowel.

IV. INCONSISTENT VISUAL UNITS FROM TEST I RESULTS

The visually contrastive unit f-v derived from Test I results showed certain inconsistencies, a confusion of f- with r-, and of v- with đ-. The unit was nevertheless regarded as distinctive since f- and v- contrasted with all other members of the other three units. Certain test items were selected to re-check these ambiguities under the different experimental conditions of Test II.

In the minimal pairs reed-feed and rule-fool, test results indicate no confusion between r- and f-, with the possible exception of fr- cluster responses. These ranged from 3% for fool to 21% for feed, full-face view, although no one gave this response for either reed or rule. Beyond this, r- was never perceived as f-, and f- was never perceived as r- alone, although there were 3% r-cluster responses for fool.

While the v-đ confusion could not be tested with these phonemes, three almost-minimal sets contrasting f- and θ- were included in the test. Comparing these responses, it was found that correct response percentages by group ranged from 93 to 100% for both f- and θ- under both view angles;

while there were cases where one was guessed for the other, these guesses in no case equalled the random guesses given other consonants or clusters.

Because objections had been raised concerning the group of *w-r* set up on the basis of the first test, three minimal pairs were included to test the possibility of visual discrimination within this group. Comparison of these responses is presented by means of a confusion matrix in Table 16.

It is apparent from this table that *w-* was rarely perceived as *r-*, and that, counting responses giving consonant clusters with *w-* (the majority of which were *hw-*), it achieved a high percentage of correct responses. On the other hand, *r-*, even when clusters with *r-* were counted as correct perceptions, did not have a correct response percentage higher than 50. However, since the remaining responses to *r-* are almost entirely *w-* or clusters with *w-*, the grouping of the two consonants into a homophenous unit appears justified. The phenomenon of nonreciprocal confusions has already been encountered in the discussion of alveolar and alveopalatal consonants, and will be covered again in the description of Test III.

TABLE 16

CONFUSION MATRIX: ROUNDED LABIAL CONSONANTS

Test Item	Word	Response Frequencies %				
		w-	C+w-	r-	C+r	Other
33.	weed	72	26	1		1
125.	reed	43	31	17	8	1
99.	wing	61	36	2		1
116.	ring	31	21	38	10	
5.	witch	57	42	1		
174.	ridge	35	18	46		1

TABLE 17

CONFUSION MATRIX: CONSONANT INITIALS
Visual, Full-Face View

(N = 106)

Stimulus	p- b- m-	pr- br-	pl- bl-	py- by- my-	spr-	sp- sm-	spl-	w- hw-	kw-	tw- sw- skw- skr-	r-	kr- gr-	tr- dr- str- šr-	θr-	f- v-	fr-	fl-	fy- vy-	sf-	θ- ð-	č- ǰ- š-	t- d-	st- sl- sk-	s- z- sn-	y- ky- hy-	n- l- kl- gl-	k- g-	h- ø-
p- b- m-	.93	.03	.02																									
pr- br-	.28	.60	.02					.04			.03															.01		
(pl-) bl-	.26	.07	.61																									
(py-) by- my-	.62	.06	.26	.04																								
spr-		.01			.85	.04	.01	.03		.03													.01					.01
sp- sm-	.04					.93																						
spl-	.06		.02		.02	.53	.35																					
w- hw-								.93	.01	.01	.03																	
kw-								.55	.17	.09	.06	.07	.03															
tw- sw- skw- skr-								.04		.82			.10	.01							.01							
r-	.02	.01						.37		.01	.49	.03	.02															.01
kr- gr-								.07	.01	.03	.19	.40	.23									.01						.03
tr- dr- str- šr-										.35			.58								.02		.02					
θr-	.01					.06				.09	.03		.17	.59						.03								
f- v-															.80	.15	.02											
fr-														.01	.28	.69	.02											
fl-															.39	.25	.35											
fy- (vy-)										.01				.01	.68	.04	.08	.16				.01						
sf-								.02		.06			.02		.32	.04			.40	.02	.02			.04				.02
θ- (ð-)															.02					.89		.02	.01	.02		.01		
č- ǰ- š-																					.86	.03	.05	.02				
t- d-													.02								.22	.23	.30	.12	.01	.02	.03	.02
st- sl- sk-										.02			.02								.10	.05	.58	.17		.01	.01	
s- z- sn-																					.05	.15	.36	.36	.02	.02	.02	.01
y- ky- hy-																					.04	.22	.01	.02	.40	.13	.06	.08
n- l- kl- gl-											.01									.06		.09	.02	.01	.01	.55	.09	.10
k- g-	.01																					.05	.02		.01	.15	.29	.43
h- ø-	.04							.05																		.03	.05	.81

RESPONSE

TABLE 18

CONFUSION MATRIX: CONSONANT INITIALS
Visual, Profile View

(N = 113)

	p- b- m-	pr- br-	pl- bl-	py- by- my-	spr-	sp- sm-	spl-	w- hw-	kw-	tw- sw- skw- skr-	r-	kr- gr-	tr- dr- str- šr-	θr-	f- v-	fr-	fl-	fy- vy-	sf-	θ- ð-	č- ǰ- š-	t- d-	st- sl- sk-	s- z- sn-	y- ky- hy-	n- l- kl- gl-	k- g-	h- ø-
p- b- m-	.92	.02	.03																									
pr- br-	.31	.56	.03					.06			.02																	
(pl-) bl-	.23	.09	.62									.03																
(py-) by- my-	.58	.05	.28	.05																								
spr-	.01	.06	.02		.82	.01				.01				.01		.01					.01		.01	.01				
sp- sm-	.07					.88																						
spl-	.04		.05			.55	.29			.01													.02	.01		.02		
w- hw-								.93	.02		.03																	
kw-								.54	.21	.10	.03	.05	.04															
tw- sw- skw- skr-								.03		.86			.07															
r-	.02	.01						.33		.01	.52	.03	.03															.02
kr- gr-		.01						.06		.03	.22	.43	.21															.01
tr- dr- str- šr-										.20			.75								.01							
θr-						.05		.01		.02	.02		.06	.78						.03			.01				.01	
f- v-															.80	.15	.02											
fr-															.24	.73	.01											
fl-															.40	.23	.35			.02								
fy- (vy-)														.03	.68	.06	.05	.17										
sf-						.10				.02					.27				.50			.02	.06	.02		.02		
θ- (ð-)														.01						.90		.01	.03	.02				
č- ǰ- š-																					.84	.04	.07	.03				
t- d-													.01								.22	.24	.31	.13	.01	.02	.02	.01
st- sl- sk-										.01			.02								.13	.17	.52	.18	.01	.01	.02	.01
s- z- sn-																					.07	.14	.35	.36	.01	.03		.01
y- ky- hy-											.01										.05	.22	.02	.01	.38	.15	.08	.05
n- l- kl- gl-												.02								.08		.08	.03		.01	.56	.08	.10
k- g-	.01																					.05			.02	.14	.29	.45
h- ø-	.02							.04																		.02	.08	.81

TABLE 19

CONFUSION MATRIX: CONSONANT INITIALS

Full-face View, Deaf Subjects

(N = 32)

	p-b- m-	pr- br-	pl- bl-	py- by- my-	spr-	sp- sm-	spl-	w- hw-	kw-	tw- sw- skw- skr-	r-	kr- gr-	tr- dř- str- šr-	θr-	f- v-	fr-	fl-	fy- vy-	sf-	θ- ð-	č- ǰ- š-	t- d-	st- sl- sk-	s- z- sn-	y- ky- hy-	n- l- kl- gl-	k- g-	h- ø-
p- b- m-	.92	.02	.03			.01																						
pr- br -	.28	.67	.02		.01			.01			.01	.01																
(pl-) bl-	.20	.13	.63					.03																				
(py-) by- my-	.41	.10	.45	-		.02																		.02				
spr-					1.00																							
sp- sm-	.10					.87																		.01			.02	
spl-	.12		.12			.25	.25																.06	.12			.06	
w- hw-	.01							.80	.02		.12												.02					
kw-								.50	.14	.05	.06	.08	.14									.02		.02				
tw- sw- skw- skr-	.01						.01	.03		.70	.02	.01	.18	.02							.01		.01				.01	
r-	.02	.01				.01		.28	.01	.02	.52	.03	.06										.01				.01	.01
kr- gr-		.01						.04	.01	.08	.19	.47	.18			.01												
tr- dř- str- šr-	.01							.01		.33	.02	.05	.56	.01									.01	.01				
θr-	.02					.02					.16		.21	.56								.02						
f- v-	.01														.74	.22	.02	.01									.01	
fr-														.03	.24	.70	.03											
fl-															.09	.27	.59							.04				
fy- (vy-)															.55	.13		.32										
sf-	.08														.38				.46								.08	
θ- (ð-)														.06	.01					.79		.07	.02	.01		.02	.02	
č- ǰ- š-													.01		.01						.69	.07	.07	.08	.02	.01	.03	
t- d-													.01	.01							.08	.27	.32	.19	.02	.03	.04	.01
st- sl- sk-													.01								.03	.10	.54	.23	.01	.04	.03	.01
s- z- sn-																					.05	.23	.24	.42		.03	.01	.01
y- ky- hy-	.01											.01	.02								.04	.29	.04	.05	.24	.16	.11	.04
n- l- kl- gl-	.01		.01								.01	.02								.03		.16		.02	.01	.51	.17	.04
k- g-																						.07	.01	.02		.04	.60	.24
h- ø-	.02							.03														.01		.01	.01		.19	.72

TABLE 20

CONFUSION MATRIX: CONSONANT INITIALS
Profile View, Deaf Subjects

(N= 32)

	p- b- m-	pr- br-	pl- bl-	py- by- my-	spr-	sp- sm-	spl-	w- hw-	kw-	tw- sw- skw- skr-	r-	kr- gr-	tr- dr- str- šr-	θr-	f- v-	fr-	fl-	fy- vy-	sf-	θ- ð-	č- ǰ- š-	t- d-	st- sl- sk-	s- z- sn-	y- ky- hy-	n- l- kl- gl-	k- g-	h- ø-
p- b- m-	.90	.02	.04			.01					.01																	
pr- br-	.26	.64	.02		.01	.01		.01		.01	.02											.01	.01	.03				
(pl-) bl-	.29	.27	.31			.02					.02										.02			.07				
(py-) my- by-	.45	.04	.40	-		.09																		.02				
spr-		.09			.87																						.04	
sp- sm-	.12		.02			.75				.01			.01		.01						.01	.01	.01	.01		.01	.01	.01
spl-	.12		.19			.69	-																					
w- hw-								.73	.03	.01	.22												.01					
kw-	.01							.51	.12	.06	.10	.10	.09	.01														
tw- sw- skw- skr-								.09		.65	.01	.04	.16									.01		.02			.01	
r-	.02	.01				.01		.24		.02	.54	.05	.04		.01						.01	.01		.01				.02
kr- gr-	.01							.05		.07	.40	.39	.06	.01										.01				
tr- dr- str- šr-									.01	.25	.03	.03	.64								.02		.01	.01		.01		
θr-	.04					.04					.08			.76						.06		.02						
f- v-															.71	.24	.01	.01		.01							.01	
fr-															.13	.85						.02						
fl-															.35	.31	.35											
fy- (vy-)								.03						.03	.79	.14		-										
sf-		.09													.46				.18		.09	.09					.09	
θ- (ð)-														.02		.01				.84	.02	.09		.01		.01	.01	
č- ǰ- š-																					.67	.14	.06	.07	.03	.01	.02	
t- d-																					.13	.34	.28	.16	.03	.02	.03	.01
st- sl- sk-	.02																				.09	.12	.48	.21	.02	.02	.04	.01
s- z- sn-											.01									.01	.08	.25	.16	.40	.05		.02	.01
y- ky- hy-											.02										.08	.30		.04	.29	.10	.09	.08
n- l- kl- gl-	.01										.04	.01				.01				.04	.02	.16	.01	.04	.03	.28	.27	.08
k- g-	.01										.01										.01	.03	.01	.01	.01	.02	.62	.26
h- ø-	.02							.01													.01	.03			.01	.02	.24	.65

TABLE 21

CONFUSION MATRIX: CONSONANT INITIALS
Auditory Condition

(N = 100)

	p	b	m	w	r	f	v	θ	đ	t	d	n	l	s	z	y	č	ǰ	š	k	g	h	ø	cc+	cc-
p-	.52									.02										.11		.33		.01	.01
b-		.95				.02					.01														
w-				.91																				.08	
r-					.96																			.04	
f-	.02	.01				.84		.08						.01								.02	.00	.01	.02
v-		.03			.01		.96																		
θ-	.01	.03				.25		.49		.03				.06								.01			.10
t-	01									.98												.01			
d-		.01									.97														.01
n-			.09									.86	.03			.02									
l-					.02								.95		.01									.01	
s-		.02				.26		.07	.01					.55										.01	.04
z-											.04				.93										.03
y-												.02				.96								.01	
č-										.02							.97		.01						
ǰ-																		1.00							
š-																	.09		.90						
k-	.02									.01										.91		.05			
g-		.02									.02					.08					.88				
h-	.08					.01														.01		.89			
ø-																							.99		

TABLE 22

CONFUSION MATRIX: CONSONANT FINALS
Visual, Full-Face View
(N = 106)

	-p-b-m	cc+	cc-	-f-v	cc+	cc-	č-ǰ-š-ž	cc+	cc-	-θ-đ	cc+	cc-	-t-d	cc+	cc-	-n	cc+	cc-	-l	cc+	cc-	-s-z	cc+	cc-	-k-g	cc+	cc-	-ŋ	cc+	cc-	-ø	cc+	cc-
-p-b-m	.87	.10											.01																		.01		
-f-v	.01			.74	.20					.01			.01																		.01		
-č-ǰ -š-ž	.01						.78	.06	.03				.02									.08									.02		
-θ (-đ)	.01						.01			.50	.03		.10			.01			.08			.08			.01						.16		
-t-d	.01			.01			.06			.01			.39	.62	.03	.04			.04			.11			.07			.02			.08		
-n	.03						.01						.17			.12	.02	.05	.18			.02			.14			.02			.25		
-l	.02									.03			.08			.03			.57	.03	.01	.01			.01						.20		
-s-z	.02						.03						.32			.01			.01			.39	.15	.02	.03						.03		
-k-g	.03						.01						.21			.11			.07			.01			.27	.02	.03	.03			.22		
-ŋ	.03			.01									.09			.05			.11			.01			.07			.18	.02	.02	.42		
-ø	.06			.02						.01			.04			.02			.11			.01			.01			.03			.66		.03

TABLE 23

CONFUSION MATRIX: CONSONANT FINALS
Visual, Profile View

(N = 113)

	-p-b-m	cc+	cc-	-f-v	cc+	cc-	-č-ǰ-š-ž	cc+	cc-	-θ-ð	cc+	cc-	-t-d	cc+	cc-	-n	cc+	cc-	-l	cc+	cc-	-s-z	cc+	cc-	-k-g	cc+	cc-	-ŋ	cc+	cc-	-ø	cc+	cc-
-p-b-m	.88	.08											.01																		.01		
-f-v	.01			.73	.21	.01				.02			.01																		.01		
-č-ǰ -š-ž							.82	.05	.02				.02									.06									.01		
-θ (-ð)										.48	.02	.02	.09			.02			.07			.09									.20		
-t-d	.01						.07			.01			.37	.14	.03	.04			.02			.12			.07			.02			.09		
-n	.03												.19			.13	.03	.06	.13			.01			.17			.02			.22		
-l	.01									.04			.10			.02			.54	.03		.01			.02						.22		
-s-z	.01						.02						.32			.01						.40	.16	.02	.03			.01			.02		
-k-g	.02						.01						.20			.11			.06			.01			.30	.04	.04	.03			.17		
-ŋ	.03												.13			.05			.12			.01			.08			.18	.04	.02	.35		
-ø	.05			.01						.01			.05			.02			.10			.01			.01			.03			.69		.02

TABLE 24

CONFUSION MATRIX: CONSONANT FINALS
Full-Face View, Deaf Subjects

(N = 32)

	-p-b-m	cc+	cc-	-f-v	cc+	cc-	-č-ǰ-š-ž	cc+	cc-	-θ-đ	cc+	cc-	-t-d	cc+	cc-	-n	cc+	cc-	-l	cc+	cc-	-s-z	cc+	cc-	-k-g	cc+	cc-	-ŋ	cc+	cc-	-ø	cc+	cc-
-p-b-m	.86	.11											.01																		.01		
-f-v	.01			.83	.07		.01			.01			.02			.01						.01			.01						.03		
-č-ǰ -š-ž							.72	.08	.06				.02			.01			.01			.06			.01						.04		
-θ (-đ)										.44	.02	.04	.12			.06			.04			.10									.19		
-t-d							.04						.36	.14	.03	.07			.02			.13			.10			.02			.09		
-n							.01						.16			.17	.03	.08	.08			.02			.23			.02			.18		
-l	.01												.09			.07			.57	.08		.01			.02						.16		
-s-z	.01												.29			.02						.41	.12	.02	.04			.02			.06		
-k-g													.12			.12			.04			.01			.44	.03	.04	.03			.15		
-ŋ				.02									.07			.06			.04			.01			.23			.19	.07	.01	.30		
-ø	.04						.01						.05			.04			.11			.02			.02			.05			.64		.02

TABLE 25

CONFUSION MATRIX: CONSONANT FINALS
Profile View, Deaf Subjects
(N = 32)

	-p-b-m	cc+	cc-	-f-v	cc+	cc-	-č-ǰ-š-ž	cc+	cc-	-θ (-ð)	cc+	cc-	-t-d	cc+	cc-	-n	cc+	cc-	-l	cc+	cc-	-s-z	cc+	cc-	-k-g	cc+	cc-	-ŋ	cc+	cc-	-ø	cc+	cc-
-p-b-m	.88	.08														.01															.01		
-f-v	.01			.80	.12	.02	.01			.02						.01															.01		
-č-ǰ-š-ž							.74	.03	.03	.01			.04						.01			.11			.01						.01		
-θ (-ð)	.03						.02			.50			.05			.03						.05									.31		
-t-d	.01						.02						.40	.13	.04	.05			.02			.12			.08			.02			.11		
-n	.02						.01						.19			.16	.04	.06	.04			.04			.25			.01			.18		
-l	.02									.03			.11			.07			.43	.05	.02	.02			.03						.23		
-s-z	.02												.41			.02			.01			.35	.06		.05			.01			.06		
-k-g	.04												.17			.10			.01			.02			.41	.03	.02	.02			.16		
-ŋ	.06												.11			.06			.03						.21			.19	.04	.02	.28		
-ø	.09			.02			.01						.05			.02			.04			.03			.03			.04			.63		.04

TABLE 26

CONFUSION MATRIX: CONSONANT FINALS
Auditory Condition

(N = 100)

	p	b	m	f	v	θ	ð	t	d	n	l	s	z	č	ǰ	š	ž	k	g	ŋ	ø	cc+	cc-
-p	.71			.01				.17										.14			.01		.01
-b	.01	.59				.04			.01	.02									.03		.30		
-m	.01		.81	.01																		.01	.02
-f	.22			.54		.05		.08	.02			.01						.03					.01
-v		.44			.30			.05	.04	.01	.02	.02	.01								.04		.05
-θ	.14			.08		.44		.04	.03					.01				.04	.01	.04	.13		.05
-t								.96										.01				.02	
-d	.01			.01	.01	.02	.03	.04	.75	.01			.01					.01	.01	.01	.06	.01	.01
-n			.09							.76										.06	.02	.04	.01
-l			.01								.92										.03	.03	
-s	.06	.01		.03		.01		.19	.03		.01	.48		.01				.07	.01		.03	.03	.02
-z	.01	.02	.03		.01			.01	.14	.03	.02	.01	.61					.01			.08		.02
-č														.98		.01		.01					
-ǰ														.10	.88								.01
-š												.05		.20		.75							
-ž				.03									.05	.01			.92		.02				
-k	.02							.02										.93				.01	.01
-g								.04		.02	.03							.03	.79	.01	.01		.04
-ŋ			.02							.08	.02								.02	.82	.02	.01	.02
-ø								.02					.01								.93		

TABLE 27

CONFUSION MATRIX: VOWEL NUCLEI
Visual, Full-Face View

(N = 106)

	-iy-i-	-ir-	-ey-e-	-er-	-ä-	-ə-	-ər-	-ay-	-a-	-aw-	-ar-	-uw-	-u-	-ur-	-ow-	-ɔy-	-ɔ-	-ɔr-
-iy-i-	.69	.02	.18	.03	.02	.02		.01									.01	
-ir-	.08	.37	.11	.08		.02	.01	.02	.01	.02		.17			.08		.01	
-ey-e-	.06		.58	.01	.19	.02		.11	.01									
-ä-			.07		.71	.01		.13	.06									
-ə-	.09		.21	.01	.02	.45	.01	.08	.10		.02							
-ay-	.03		.23		.20	.03		.43	.04								.01	
-a-					.04	.10		.04	.78		.02						.02	
-aw-										.97							.02	
-ar-			.01		.01	.01		.01	.02	.04	.26				.04		.60	
-uw-	.02					.02	.01					.81	.06	.02	.03			.01
-u-	.05					.01	.22					.09	.51	.01	.02	.02		.03
-ow-						.01						.11	.02		.79	.01	.01	.03
-ɔy-	.02		.03				.03	.01	.01				.11		.02	.54	.03	.20
-ɔ-					.01	.02		.01	.08		.06				.04	.02	.69	.04
-ɔr-						.01		.01			.02	.02	.01	.10	.05	.14	.09	.54

TABLE 28

CONFUSION MATRIX: VOWEL NUCLEI
Visual, Profile View

(N = 113)

	-iy-i-	-ir-	-ey-e-	-er-	-ä-	-ə-	-ər-	-ay-	-a-	-aw-	-ar-	-uw-	-u-	-ur-	-ow-	-ɔy-	-ɔ-	-ɔr-
-iy-i-	.72	.02	.16	.02	.02	.02		.02										
-ir-	.12	.37	.12	.07		.01	.03	.01		.02	.01	.12	.01	.01	.08		.01	.01
-ey-e-	.08		.59	.01	.16	.02		.12	.01									
-ä-	.01		.09		.68	.02		.15	.05									
-ə-	.12		.18	.01	.02	.42	.04	.06	.10		.03						.02	
-ay-	.03		.25		.24	.02		.40	.04								.01	
-a-					.02	.08		.06	.78		.04						.01	
-aw-										.97					.01		.01	
-ar-				.01		.01	.01	.01	.02	.03	.54						.38	
-uw-	.02					.01	.01		.01			.83	.06	.02	.03			.01
-u-	.06		.01				.16					.09	.59		.01	.01	.01	.03
-ow-						.01				.01		.13	.02		.76		.01	.03
-ɔy-	.03		.02			.01	.03	.01	.01	.01		.01	.15		.02	.54	.02	.14
-ɔ-					.01	.02		.01	.07		.05		.01		.04	.02	.73	.04
-ɔr-		.01										.04	.05		.04	.19	.06	.61

TABLE 29

CONFUSION MATRIX: VOWEL NUCLEI
Full-Face View, Deaf Subjects

(N = 32)

	-iy-i-	-ir-	-ey-e-	-er-	-ä-	-ə-	-ər-	-ay-	-a-	-aw-	-ar-	-uw-	-u-	-ur-	-ow-	-ɔy-	-ɔ-	-ɔr-
-iy-i-	.69		.18	.02	.03	.03	.01	.03	.01									
-ir-	.15	.33	.11	.10			.03	.04		.05		.06		.02	.08			.02
-ey-e-	.09		.53	.01	.22	.02		.11										
-ä-	.02		.05		.73	.02		.14	.02									
-ə-	.09		.15		.05	.52	.04	.06	.06								.01	
-ay-	.06		.16		.16	.03		.54	.04								.01	
-a-					.04	.17		.02	.74		.02	.01	.01				.01	
-aw-										1.00								
-ar-							.04				.64				.04		.28	
-uw-	.02					.01	.03					.79	.02	.01	.08			.01
-u-	.07		.02				.20					.09	.54		.06			.03
-ow-							.01					.08	.01		.84		.01	.04
-ɔy-			.03			.07	.01		.01				.07		.04	.61	.01	.14
-ɔ-			.01		.01	.02	.01	.01	.03		.03	.02			.04		.78	.04
-ɔr-							.04					.18		.07		.04	.04	.64

TABLE 30

CONFUSION MATRIX: VOWEL NUCLEI
Profile View, Deaf Subjects

(N = 32)

	-iy-i-	-ir-	-ey-e-	-er-	-ä-	-ə-	-ər-	-ay-	-a-	-aw-	-ar-	-uw-	-u-	-ur-	-ow-	-ɔy-	-ɔ-	-ɔr-
-iy-i	.64		.20	.01	.03	.03		.04	.02			.01						
-ir-	.17	.21	.10	.08	.01	.06	.04	.06		.06		.11	.01	.01	.07			
-ey-e-	.10		.50	.01	.22	.03		.11	.02									
-ä-	.02		.12		.59	.05		.15	.05								.01	
-ə-	.14		.14		.07	.40	.06	.06	.09		.01						.01	.01
-ay-	.06		.23		.18	.02		.45	.04									
-a-	.01		.02		.03	.19		.02	.64		.05	.01	.01				.03	
-aw-			.02							.98								
-ar-			.06						.03		.87						.03	
-uw-	.01					.01	.01					.85	.02	.01	.07			.02
-u-	.08		.02				.18					.12	.57		.03			.01
-ow-						.01				.02		.13	.01		.73	.01	.03	.06
-ɔy-	.01		.01		.01	.01							.06		.08	.49	.02	.30
-ɔ-	.01		.01		.01				.03		.04	.02			.04	.01	.76	.06
-ɔr-												.07	.03			.03	.07	.79

6. FILM TEST III

EXPERIMENTAL DESIGN

Stimulus units for Test I were presented as pairs of minimally-distinctive nonsense syllables, to the members of which subjects were asked to respond as "alike" or "different". As a result of these procedures, it was not possible to determine whether the confusions found were reciprocal.

In order to clarify the nature of the perceptual confusions suggested by the first experiment--as well as to provide additional data on the visual perception of speech units--the 25 consonant-initial allophones of English were re-tested under conditions which duplicated the linguistic controls and environments imposed for Test I, but which differed in testing and analytic procedures.

The 75 nonsense syllables (*Ca·*) of Test III were presented as a series of *single* stimulus units, and the task of the subject was to *identify* the initial consonant of each syllable. Use of the *Ca·* syllable was necessary here, as in the first experiment, to maintain the controls of a constant and non-redundant phonetic environment. The rationale for these controls, and for selection of the *Ca·* formula in these terms is discussed in Section 4 of this report.

Although the film was produced at the same time as Test II, the nonsense-syllable test was not a part of that experiment; i.e., it was not to be administered at the same time, nor to the same subjects, as the test which utilized lexical items as stimuli. It should be noted, however, that including this design in second-stage experimentation obviated the necessity of controlling for idiosyncratic differences in articulation habits. Stimulus materials for all sections of Test II, Test III, and Test IV were presented by a single speaker.

The film script for the test is included as Appendix L to this report, and instructions given the subjects appear on the sample cover page reproduced as Appendix K.

RESULTS

Because of the particular nature of the experimental task discussed above, it was necessary to obtain specialized subjects for administration of Film Test III. Consequently, the results described here were obtained from a total sample of 19 subjects--members of phonetics classes at the University of California, Los Angeles and Los Angeles State College. Presenting the film to phonetics students made it unnecessary to train subjects in phonemic transcription to indicate consonants for which English spelling is ambiguous or inconsistent. Further, it provided subjects who are interested in linguistic problems and who were used to thinking in terms of linguistic units.

It should be mentioned also that one of the 75 views of the speaker uttering nonsense syllables was defective. Since each initial consonant was presented three times, however, it was felt that one omission would not seriously distort results. (The syllable omitted was No. 36, da).

Instructions to the subjects (cf. Appendix K) listed the initial consonants to be expected in the test. This was necessary because nine of the nonsense syllables in the film script began with initial elements which do not normally appear initially in English words, or are not normally considered initial consonants: ž, W (usually phonemicized as the cluster hw-), and ∅ (simply a·), with no initial consonant.

The results of the test are presented below, according to visually-contrastive units which appear to be confirmed by the response patterns. It should be noted that each consonant was presented three times in the test with 19 subjects so that there were 57 chances for a correct perception (except for d-, the omitted consonant, for which only 38 chances for correct perception were possible). Correct perception for groups increase the total number of possible chances, according to the number of consonants included in each unit.

In comparison with the results of Test I, data from Test III yield seven visually-contrastive groups among the 25 analytic units tested. These are listed below in order of percentage of correct responses; confusions within each unit shown are roughly proportional to the number of consonants included in each (except as noted below):

1.	p-b-m	96%
2.	f-v	92
3.	č-ǰ-š-ž	85

4.	W-w-r	82%
5.	θ-ð-l	71
6.	k-g-h-∅	70
7.	t-d-n-s-z-y	63

Groups 1, 2 and 4 (above) correspond to units derived from Test I results. Groups 3, 5, 6, and 7, however, contain consonants which were grouped together in earlier results. The possibilities for distinguishing between members of the large group of nonlabial consonants (labeled group 4 in Test I results) appear to be confirmed by Test II (see the discussions of the view-angle hypothesis and the inconsistent visual units).

One point remains to be discussed, however, concerning the placement of certain initial consonants in the listing just given. The problem of nonreciprocal confusion has already been mentioned with regard to *r-* and *w-* and the alveolars and alveopalatals. The relationship of *r-* and *w-* in Test III results is very similar to that discussed for Test II: while *r-* is frequently perceived as *w-*, the reverse does not take place. In Test III results, the same is true of *l-* and the dental spirants. Other unequal confusions are found in the alveolar group; *n-* was perceived as velar just as often in this sample as it was as an alveolar. In addition, the semivowel *y-*, classified as an alveopalatal, had more alveolar responses than any other kind, almost 50%. On the contrary, only three subjects identified any of the 75 initial consonants in the test as *y-*, none of the responses being correct (once each *g-*, *h-*, and *∅-*).

This same phenomenon may be noted with *m-*, highly visible with only two other consonants with which it may readily be confused. In Test III results, however, *m-* was identified as *p-* or *b-* 88% of the time, while *p-* and *b-* were rarely identified as *m-*. Related to this problem, perhaps, is the fact that combined responses to all the voiceless-voiced pairs in Test III showed higher frequencies for the voiceless member of the pairs. Thus, *p-*, *f-*, *θ-*, *t-*, *s-*, *č-*, *š-*, and *k-* were all represented in the response frequencies a greater number of times than their voiced counterparts. Tests of statistical significance have not been run, but in most cases they are obviously unnecessary, such as 80% of *f-* responses, as opposed to 12% *v-* responses, for the combined total of 114 chances to perceive a labiodental spirant, without regard to voicing. (This corresponds with the responses in Test II to item 96, *voice*, which was identified by most subjects as 'force', despite the fact that -ɔy- in other words is identified correctly over 90% of the time.) While the preference for voiceless consonants in test responses may be due to the fact that the subjects are seeing the films without sound, some unknown factors of phoneme expectancy may be present.

Because of the extremely small population sample utilized in this experiment compared to those used in earlier tests of the series--and possibly because of the specialized background of the subjects, it is felt that a number of questions have been left unanswered by administration and analysis of Film Test III. Although this research project has officially been completed, then, it is hoped to explore some of these questions further by administering the test again as specialized subjects become available. Also, as a control condition, it might be advisable to train subjects in recording techniques, so that the test can be administered as well to persons less sophisticated in dealing with linguistically defined units.

7. FILM TEST IV

Procedures. Utilizing a version of the film produced for Test II, Film Test IV was designed to check a number of specific dimensions of difference outlined for the major series of experiments (cf. Classification of Variables in Section 5 of this report).

For this test, the task of the subject was to make a forced choice between two members of pairs of words listed on the answer sheets. Since the random order of stimulus units was already fixed by the film, the order of presentation of members of each pair on the answer sheets was randomized by reference to odd and even digits in a table of random numbers (see Appendices M and N).

Because of the nature of the experimental design, the 198 stimulus units of the film yielded 99 paired comparisons; i.e., each pair selected was tested twice. It should be noted, however, that not every pair represents a crucial comparison because many of the original 198 words of the test were selected to test several dimensions of difference in an open-choice test, it follows that the pairing of these would leave a residual of a few pairs for which no significant confusion would be predicted, (e.g., Nos. 2 and 23, grass-rose).

It should be noted also that no view-angle variables were included in this test, and that auditory and audio-visual controls were not maintained. Only the full-face view of the visual form of the test was administered.

Results. Test IV was given to 100 normal-hearing adult speakers of English, most of whom were undergraduate students in the School of Education, University of California, Los Angeles. It was administered as well to 75 upper-school students at the California School for the Deaf, Riverside.

The purposes of this experiment were specific, and the results are presented in specific form, viz., by means of confusion matrices indicating the percentage of responses to each pair of words tested. These results are summarized in Tables 31 and 32.

TABLE 31

CONFUSION MATRICES, TEST IV-v
(N = 100)

		skwiyz	swiyt
1.	squeeze	.41	.59
172.	sweet	.58	.42

		gra̋s	rowz
2.	grass	.99	.01
23.	rose	.01	.99

		prays	prayz
3.	price	.86	.14
112.	prize	.27	.73

		sɔŋ	šɔl
4.	song	.77	.23
87.	shawl	.04	.96

		wič	riǰ
5.	witch	.86	.14
174.	ridge	.59	.41

		rek	wik
6.	wreck	.76	.24
14.	wick	.18	.82

		čiyf	siv
7.	chief	.89	.11
68.	sieve	.15	.85

		buwt	bowt
8.	boot	.95	.05
157.	boat	.15	.85

		gla̋s	ga̋s
9.	glass	.70	.30
80.	gas	.31	.69

		spriy	smir
10.	spree	.95	.05
198.	smear	.06	.94

		dir	sir
11.	deer	.39	.61
66.	seer	.38	.61

		sayn	slayd
12.	sign	.41	.59
42.	slide	.28	.72

		fɔg	fɔn
13.	fog	.55	.45
71.	fawn	.52	.48

		glayd	layt
15.	glide	.74	.26
158.	light	.19	.81

		kown	kowl
16.	cone	.54	.46
114.	coal	.16	.84

		ruwl	wul
17.	rule	.79	.21
37.	wool	.28	.72

		dɔr	dow
18.	door	.98	.02
105.	dough	.15	.85

		šred	šed
19.	shred	.97	.03
113.	shed	.02	.98

		spiyd	riyd
20.	speed	.99	.01
125.	reed	.03	.97

		fut	fown
21.	foot	.97	.03
197.	phone	.04	.96

		reyn	treyn
22.	rain	.88	.12
145.	train	.06	.94

		feyt	freyt
24.	fate	.66	.34
59.	freight	.11	.89

		fig	fin
25.	fig	.62	.38
118.	fin	.61	.39

		liyč	liyš
26.	leech	.59	.41
166.	leash	.37	.63

		lowd	lowf
27.	load	.94	.06
86.	loaf	.01	.99

		sfir	fir
28.	sphere	.90	.09
137.	fear	.14	.86

		hed	hud
29.	head	.99	.00
196.	hood	.00	1.00

		θiŋ	θəg
30.	thing	.84	.16
38.	thug	.19	.81

		sniyz	niys
31.	sneeze	.79	.21
107.	niece	.11	.89

		ruwf	vɔys
32.	roof	.98	.02
96.	voice	.00	1.00

		wiyd	hwiyt
33.	weed	.24	.76
44.	wheat	.12	.88

		gir	ir
34.	gear	.54	.46
70.	ear	.29	.71

		tap	tayp
35.	top	.91	.09
147.	type	.19	.81

		bəs	buk
36.	bus	.99	.01
94.	book	.01	.99

		kyuw	hyuw
39.	cue	.47	.53
89.	hue	.28	.72

		səm	čəm
40.	sum	.95	.05
79.	chum	.06	.94

		prowz	powz
41.	prose	.50	.50
49.	pose	.16	.84

		pat	bɔs
43.	pot	.83	.17
148.	boss	.12	.88

		spuwl	bɔy
45.	spool	1.00	.00
122.	boy	.00	1.00

		deyt	dɔg
46.	date	1.00	.00
61.	dog	.00	1.00

		gəm	kap
47.	gum	.34	.66
159.	cop	.03	.97

		ruwž	ruwt
48.	rouge	.77	.23
186.	root	.16	.84

		zuw	skuwl
50.	zoo	.66	.34
161.	school	.01	.99

		twič	trik
51.	twitch	.99	.01
163.	trick	.12	.88

		briyd	bred
52.	breed	.52	.48
176.	bread	.07	.93

		šuw	stuwl
53.	shoe	.88	.12
111.	stool	.55	.45

		fayt	fiyd
54.	fight	.99	.01
150.	feed	.03	.97

		na̋p	la̋m
55.	nap	.78	.21
155.	lamb	.20	.80

		guws	huwč
56.	goose	.73	.27
100.	hooch	.09	.91

		hɔl	kɔl
57.	hall	.87	.13
192.	call	.23	.77

		skiym	tiym
58.	scheme	.79	.21
156.	team	.67	.33

		čin	ǰin
60.	chin	.55	.45
141.	gin	.58	.42

		siyǰ	dič
62.	siege	.38	.62
91.	ditch	.16	.84

		bid	bin
63.	bid	.46	.54
167.	bin	.34	.66

		myuwl	puwl
64.	mule	.58	.42
188.	pool	.16	.84

		twiyd	kwiyn
65.	tweed	.87	.13
165.	queen	.36	.64

		kat	keyn
67.	cot	1.00	.00
93.	cane	.06	.94

		tuwb	suwp
69.	tube	.42	.58
85.	soup	.33	.67

		byuwt	bruwt
72.	butte	.41	.59
106.	brute	.20	.80

		spayn	splays
73.	spine	.94	.06
88.	splice	.06	.94

		teyp	ta̋b
74.	tape	.81	.19
132.	tab	.07	.93

		bet	beyt
75.	bet	.51	.48
82.	bait	.45	.55

		yir	yuw
76.	year	.21	.79
146.	you	.01	.99

		kiŋ	kiy
77.	king	.44	.56
130.	key	.10	.90

		luwm	ruwm
78.	loom	.80	.20
149.	room	.06	.94

		siyd	skriyn
81.	seed	.99	.01
175.	scream	.02	.98

		weyk	kweyk
83.	wake	.42	.58
119.	quake	.29	.71

		flayt	frayt
84.	flight	.67	.33
139.	fright	.09	.91

		siym	stiym
90.	seam	.48	.52
190.	steam	.48	.52

		ba̎t	bayt
92.	bat	.81	.19
124.	bite	.24	.76

		striym	driym
95.	stream	.78	.22
109.	dream	.69	.31

		kwa̎k	wɔk
97.	quack	.98	.02
138.	walk	.01	.99

		θɔt	θɔŋ
98.	thought	.91	.08
103.	thong	.15	.85

		wiŋ	wig
99.	wing	.38	.62
169.	wig	.52	.48

		riyθ	riyf
101.	wreath	.91	.09
183.	reef	.07	.93

		lik	klik
102.	lick	.57	.43
140.	click	.24	.76

		tin	šin
104.	tin	.53	.47
184.	shin	.05	.95

		bluwm	bruwm
108.	bloom	.75	.25
152.	broom	.15	.85

		kowt	kowd
110.	coat	.89	.11
143.	code	.42	.58

		θred	θəm
115.	thread	1.00	.00
181.	thumb	.00	1.00

		riŋ	greyn
116.	ring	.67	.33
123.	grain	.03	.97

		fəǰ	ǰəǰ
117.	fudge	.98	.02
191.	judge	.01	.99

		kik	keyk
120.	kick	61	.39
128.	cake	.04	.96

		təg	rəg
121.	tug	.99	.01
127.	rug	.01	.99

		fyuwl	fuwl
126.	fuel	.64	.36
178.	fool	.17	.83

		payl	bil
129.	pile	1.00	.00
160.	bill	.03	.97

		blayt	bawt
131.	blight	.99	.01
134.	bout	.03	.97

		tuwθ	tuwl
133.	tooth	.46	.54
136.	tool	.06	.94

		kriym	riym
135.	cream	.82	.18
162.	ream	.29	.71

		yɔn	dɔn
142.	yawn	.55	.45
154.	dawn	.29	.71

		tɔk	čɔk
144.	talk	.34	.66
189.	chalk	.10	.90

		šap	ǰab
151.	shop	.91	.09
194.	job	.60	.40

		biyt	bit
153.	beet	.59	.41
177.	bit	.29	.70

		awl	ɔyl
164.	owl	.98	.02
171.	oil	.01	.99

		θrɔŋ	rɔŋ
168.	throng	.89	.11
187.	wrong	.04	.96

		skiy	čir
170.	ski	.99	.01
180.	cheer	.01	.99

		ay	hil
173.	eye	.98	.02
193.	hill	.00	1.00

		θiyf	liyf
179.	thief	.97	.03
195.	leaf	.22	.78

		kar	kaw
182.	car	.88	.12
185.	cow	.00	1.00

TABLE 32

CONFUSION MATRICES, TEST IV-vd

(N = 75 Deaf Subjects)

		skwiyz	swiyt
1.	squeeze	.41	.59
172.	sweet	.43	.57

		gra̎s	rowz
2.	grass	.96	.04
23.	rose	.04	.96

		prays	prayz
3.	price	.59	.39
112.	prize	.41	.59

		sɔŋ	šɔl
4.	song	.85	.15
87.	shawl	.07	.93

		wič	riǰ
5.	witch	.88	.12
174.	ridge	.68	.32

		rek	wik
6.	wreck	.37	.60
14.	wick	.43	.57

		čiyf	siv
7.	chief	.92	.08
68.	sieve	.28	.72

		buwt	bowt
8.	boot	.84	.16
157.	boat	.07	.93

		gla̎s	ga̎s
9.	glass	.65	.35
80.	gas	.20	.80

		spriy	smir
10.	spree	.91	.09
198.	smear	.31	.68

		dir	sir
11.	deer	.63	.36
66.	seer	.39	.60

		sayn	slayd
12.	sign	.83	.17
42.	slide	.24	.76

		fɔg	fɔn
13.	fog	.83	.17
71.	fawn	.48	.52

		glayd	layt
15.	glide	.51	.49
158.	light	.19	.81

		kown	kowl
16.	cone	.59	.41
114.	coal	.32	.67

		ruwl	wul
17.	rule	.59	.41
37.	wool	.31	.69

		dɔr	dow
18.	door	.93	.07
105.	dough	.55	.45

		šred	šed
19.	shred	.97	.03
113.	shed	.23	.77

		spiyd	riyd
20.	speed	.99	.01
125.	reed	.04	.96

		fut	fown
21.	foot	.96	.04
197.	phone	.13	.87

		reyn	treyn
22.	rain	.81	.19
145.	train	.07	.93

		feyt	freyt
24.	fate	.64	.36
59.	freight	.15	.85

		fig	fin
25.	fig	.51	.49
118.	fin	.49	.51

		liyč	liyš
26.	leech	.52	.48
166.	leash	.55	.45

		lowd	lowf
27.	load	.99	.01
86.	loaf	.00	1.00

		sfir	fir
28.	sphere	.73	.27
137.	fear	.11	.89

		hed	hud
29.	head	.99	.01
196.	hood	.00	1.00

		θiŋ	θəg
30.	thing	.91	.09
38.	thug	.12	.88

		sniyz	niys
31.	sneeze	.48	.52
107.	niece	.11	.89

		ruwf	vɔys
32.	roof	1.00	.00
96.	voice	.03	.97

		wiyd	hwiyt
33.	weed	.41	.59
44.	wheat	.41	.59

		gir	ir
34.	gear	.39	.61
70.	ear	.29	.71

		tap	tayp
35.	top	.93	.07
147.	type	.25	.75

		bəs	buk
36.	bus	1.00	.00
94.	book	.01	.99

		kyuw	hyuw
39.	cue	.63	.37
89.	hue	.55	.45

		səm	čəm
40.	sum	.89	.11
79.	chum	.11	.89

		prowz	powz
41.	prose	.64	.36
49.	pose	.35	.64

		pat	bɔs
43.	pot	.55	.45
148.	boss	.13	.87

		spuwl	bɔy
45.	spool	.99	.01
122.	boy	.01	.99

		deyt	dɔg
46.	date	1.00	.00
61.	dog	.01	.99

		gəm	kap
47.	gum	.75	.25
159.	cop	.23	.77

		ruwž	ruwt
48.	rouge	.53	.47
186.	root	.11	.89

		zuw	skuwl
50.	zoo	.87	.13
161.	school	.12	.88

		twič	trik
51.	twitch	.96	.04
163.	trick	.16	.84

		briyd	bred
52.	breed	.20	.80
176.	bread	.21	.79

		šuw	stuwl
53.	shoe	.99	.01
111.	stool	.43	.57

		fayt	fiyd
54.	fight	.96	.04
150.	feed	.08	.92

		na̋p	la̋m
55.	nap	.55	.45
155.	lamb	.37	.63

		guws	huwč
56.	goose	.91	.08
100.	hooch	.19	.81

		hɔl	kɔl
57.	hall	.76	.24
192.	call	.17	.83

		skiym	tiym
58.	scheme	.19	.81
156.	team	.23	.77

		čin	ǰin
60.	chin	.72	.28
141.	gin	.79	.21

		siyǰ	dič
62.	siege	.27	.73
91.	ditch	.16	.84

		bid	bin
63.	bid	.47	.53
167.	bin	.44	.56

		myuwl	puwl
64.	mule	.44	.56
188.	pool	.35	.65

		twiyd	kwiyn
65.	tweed	.69	.31
165.	queen	.40	.60

		kat	keyn
67.	cot	.95	.05
93.	cane	.08	.92

		tuwb	suwp
69.	tube	.21	.79
85.	soup	.33	.67

		byuwt	bruwt
72.	butte	.23	.77
106.	brute	.24	.76

		spayn	splays
73.	spine	.79	.21
88.	splice	.20	.79

		teyp	ta̋b
74.	tape	.71	.28
132.	tab	.52	.48

		bet	beyt
75.	bet	.47	.53
82.	bait	.44	.56

		yir	yuw
76.	year	.48	.52
146.	you	.01	.99

		kiŋ	kiy
77.	king	.52	.48
130.	key	.25	.75

		luwm	ruwm
78.	loom	.51	.49
149.	room	.03	.97

		siyd	skriym
81.	seed	.99	.01
175.	scream	.00	1.00

		weyk	kweyk
83.	wake	.57	.43
119.	quake	.37	.63

		flayt	frayt
84.	flight	.68	.32
139.	fright	.11	.89

		siym	stiym
90.	seam	.41	.59
190.	steam	.39	.61

		ba̋t	bayt
92.	bat	.81	.19
124.	bite	.27	.73

		striym	driym
95.	stream	.37	.63
109.	dream	.45	.55

		kwa̋k	wɔk
97.	quack	.93	.07
138.	walk	.01	.99

		θɔt	θɔŋ
98.	thought	.80	.20
103.	thong	.36	.64

		wiŋ	wig
99.	wing	.41	.59
169.	wig	.44	.56

		riyθ	riyf
101.	wreath	.85	.12
183.	reef	.16	.84

		lik	klik
102.	lick	.53	.47
140.	click	.52	.48

		tin	šin
104.	tin	.43	.57
184.	shin	.08	.92

		bluwm	bruwm
108.	bloom	.36	.64
152.	broom	.13	.87

		kowt	kowd
110.	coat	.91	.08
143.	code	.52	.48

		θred	θəm
115.	thread	.99	.01
181.	thumb	.00	1.00

		riŋ	greyn
116.	ring	.80	.20
123.	grain	.15	.85

		fəǰ	ǰəǰ
117.	fudge	.96	.04
191.	judge	.03	.97

		kik	keyk
120.	kick	.52	.48
128.	cake	.21	.79

		təg	rəg
121.	tug	.99	.01
127.	rug	.01	.97

		fyuwl	fuwl
126.	fuel	.80	.20
178.	fool	.20	.80

		payl	bil
129.	pile	.80	.20
160.	bill	.15	.85

		blayt	bawt
131.	blight	.99	.01
134.	bout	.03	.97

		tuwθ	tuwl
133.	tooth	.33	.67
136.	tool	.16	.84

		kriym	riym
135.	cream	.68	.32
162.	ream	.35	.65

		yɔn	dɔn
142.	yawn	.49	.51
154.	dawn	.39	.61

		tɔk	čɔk
144.	talk	.51	.49
189.	chalk	.29	.71

		šap	ǰab
151.	shop	.60	.40
194.	job	.39	.60

		biyt	bit
153.	beet	.73	.27
177.	bit	.23	.77

		awl	ɔyl
164.	owl	1.00	.00
171.	oil	.01	.99

		θrɔŋ	rɔŋ
168.	throng	.64	.36
187.	wrong	.04	.96

		skiy	čir
170.	ski	.99	.01
180.	cheer	.03	.97

		ay	hil
173.	eye	.95	.05
193.	hill	.01	.99

		θiyf	liyf
179.	thief	.92	.08
195.	leaf	.19	.81

		kar	kaw
182.	car	.97	.03
185.	cow	.00	1.00

8. LANGUAGE AQUISITION STUDY

As has been noted in the "Major Departures" sections of several progress reports, activities for this phase of the program were curtailed by the loss of personnel originally included in project planning. For the sake of general perspective, however, the research design for perceptual discrimination testing among deaf children will be discussed as it was initially conceived, and tentative results will be presented for the short-range objectives actually achieved in the face of a general curtailment of research goals.

RESEARCH DESIGN

Because of the order of patterning universally characteristic of linguistic phenomena--i.e., the partial recurrences of elements in a larger linguistic pattern--it might be said that an individual never actually "learns" all the possible utterances of his native language. In fact, he probably learns very few of them in the classical sense; rather he infers the patterns and fabricates utterances on the basis of what he hears.

The nature of the learning processes implied in the character of language, and in the fact of speech acquisition by the human infant, is extremely important to long range research into problems of the aurally handicapped individual. Assuming that the deaf child is otherwise capable of the sort of implicit analysis which is evident in human communication, then a principal aim of applied research in this field might well be the attempt to develop techniques for activating these latent processes of language learning. Given this ultimate objective, a major question is: How can we bridge the gap from (i) the discrete conditioning practices necessary in the tutoring situation, to (ii) the sort of pattern-learning and utterance-creation which seem to arise almost spontaneously in the aurally normal child?

In a survey of educational research problems of language development (Carroll, n.d.), it is stated that "oddly enough, one never seems to think of 'teaching' a child to learn language in the early phases, or of investigating the effects of specific practices in such teaching." Congenitally deaf children, however, can acquire speech and language only by such teaching practices. Institutions for the deaf which include a nursery school program, then, provide both subjects and setting for such a study as Carroll suggests.

It was planned to supplement the perception studies by utilizing the linguistic model as a guide for observations and testing of language development in the aurally handicapped child.

The immediate goal for this phase of the project was the construction and pre-testing of a design for a study of language learning in deaf children. The ultimate goal planned for this research was a systematic description of the characteristics of language learning and speech development in the preschool and elementary-school deaf child. Developmental sequences derived in this way could be the basis for comparisons of the linguistic behavior of deaf and normal-hearing children, and the results of such comparisons could then be used in assessing specific tutoring techniques current in education of the deaf.

As an example of the data to be collected according to the levels and categories characteristic of the English language, the general question was raised: How does the linguistic behavior of the deaf child differ from that of the normal child, and to what extent are these differences a function solely of hearing loss? Alternatively, are the characteristic differences attributable in part to the nature of the tutoring situation--structured in terms of language learning--and to the institutional segregation of deaf children even in those activities which are not structured as to linguistic experiences?

Phrased more specifically in terms of the linguistic model, and with reference to teaching practices peculiar to schools for the deaf, long-range goals might be expressed in the following sample questions:

1. Phonological - What is the sequence of articulatory development in the deaf child, as compared to the normal child?
    a. How do these differences relate to experimental findings on the perceptibility of English consonantal articulations?
    b. How and to what extent is the low visibility of the majority of consonantal articulations compensated for by combined visual-tactile-auditory techniques of teaching (i.e., lipreading, feeling articulatory movements, and amplification of residual hearing)?
2. Grammatical - What is the characteristic structure of the expression system of the deaf child, and how does this relate to different teaching practices in education of the deaf? (For example, does discrete conditioning to isolated vocabulary items--typical of some tutoring procedures--manifest itself in an atomistic form of expression in the deaf child?)

3. Lexical - How does the extent of reference of lexical items within the deaf child's comprehension range compare with semantic areas typical of the normal child's vocabulary? How does this difference relate to the situation-word approach typical of some tutoring practices?

It was initially planned that data for a developmental description of the linguistic behavior of the aurally-handicapped child would be derived primarily from a program of naturalistic observations of preschool deaf children, conducted in terms of the levels and categories of the linguistic model. Extensive observations of tutoring sessions at the John Tracy Clinic (along with a survey of Clinic records and tutor's reports of the children observed) made it clear, however, that the data necessary could not be obtained by observational techniques alone. Tutoring sessions proved to be too restricted in purpose to provide the selective range of behaviors necessary to the descriptive aims outlined above, even though the initial goal prescribed a test only of phonological aspects of language learning and speech development.

For these reasons, it was decided to introduce certain experimental techniques not initially planned. Although observations and records continued to be a part of the program, these were no longer considered as the primary source of data for linguistic descriptions to be formulated. In order to supplement these techniques, then, the project was redirected toward the development of eliciting procedures designed to provide information about the expressive and perceptual aspects of phonological development in the preschool deaf child.

Preschool subjects for the study were drawn primarily from the John Tracy Clinic Demonstration Nursery School, which has an enrollment of 22 deaf children from 2-6 years of age. Follow-up studies of 60 elementary school children were also made by testing Clinic graduates and other deaf children from 7-9 years of age. By this series of procedures, it was hoped to obtain information on the developmental stages of linguistic behavior in the aurally-handicapped.

As a technique to determine the phonological distinctions made by the aurally-handicapped child, preliminary tests presented sets of minimally-different lexical items based on the tentative categories of visual difference established in the experimental studies of lipreading. Though the testing of aurally-handicapped children has not been extensive enough to allow statistical controls minimizing factors of chance, pre-tests of eliciting procedures raised the possibility of a greater visual discriminability among certain phonological features than seemed to be indicated in perception experiments with untrained normal-hearing adults. For this reason, subsequent test materials for the language acquisition study included articulatory distinctions tested in the speech perception experiments.

Test items were selected in terms of the vocabulary comprehension standard for preschool deaf children, and were restricted to those words or word-combinations which can be represented easily in pictures.

The principal technique for tests of perceptual discrimination consists of the presentation of a set of paired pictures (or objects) along with a verbal stimulus designating one of the two pictures shown. The task of the child was to select (by pointing or speaking) the picture appropriate to the word spoken by the examiner. The subject had to select, for example, between "fish" and "dish" (a comparatively easy lipreading distinction), or between "cat" and "hat" (an articulatory difference which, in nonsense-syllable tests, was shown to be virtually impossible to perceive by visual cues alone).

Though pre-testing seemed to indicate that a large amount of stimulus material does not strain the achievement level or the tolerance range of the advanced student, it is obvious that the number of test items per trial had to be restricted for younger children. A typical first-year student (2 years old) does not have a large lipreading vocabulary, and is not yet equipped to acquire new lipreading words simply by virtue of the test experience. To minimize the effect of guessing, each subject undertook, on separate occasions, three trials of each test--the trial sets differing only in the arrangement of alternative pictures with verbal stimuli.

PERCEPTUAL DISCRIMINATION TESTING

Perceptual Discrimination Test I. The pre-tests and initial testing described here were conducted to develop procedures for eliciting responses from preschool deaf children, and were not intended primarily to provide substantive data for analysis of visual perception at this level of investigation.

After pre-testing of a 40-item test with older children, ten items were selected from the larger test for use with John Tracy Clinic Demonstration Nursery School students. The 10-item test was designated Perceptual Discrimination Test I.

Data given in this discussion were collected from the administration of three trials of the 10-item perceptual discrimination test to each of 21 Nursery School children whose ages ranged from 2 years 9 months to 6 years at the time testing was started. Using the techniques described in the preceding section, a trained tutor of the deaf presented the test items to the student being examined, while members of the research staff recorded responses in an observation room equipped with a one-way mirror.

Stimuli presented in the three trials of Test I are listed in Table 33, which also shows the results of this test. Test items are presented in order of perceptibility, as determined by the percentage of correct responses of 63 possible correct choices. As examination of the table shows, the consonantal contrasts presented as word-initials in the paired stimuli were based on the tentative homophene classes derived from Film Test I of the speech perception study.

It should be noted that the results of the testing with children have been consistent with the results of the pilot experiment (cf. Table 4), though the degree of discrimination was in each case higher than would have been predicted on the basis of Film Test I data alone.

TABLE 33

PERCEPTUAL DISCRIMINATION TEST I

Item No.	PICTURED CHOICES	VERBAL STIMULUS			CORRECT CHOICES %
		Trial 1	Trial 2	Trial 3	
5.	ball - man	man	ball	man	89
7.	fish - dish	fish	dish	fish	87
1.	boat - coat	boat	coat	coat	84
4.	bed - red	bed	red	bed	81
9.	car - cow	cow	car	car	81
10.	man - moon	moon	man	moon	81
2.	milk - moon	milk	milk	moon	76
6.	cake - cat	cake	cake	cat	54
8.	cat - hat	hat	cat	hat	54
3.	jump - cup	cup	jump	jump	51

Perceptual Discrimination Test II. The second test in this series was administered not only to the 22 preschool children of the John Tracy Clinic Demonstration Nursery School, but also to three groups of 20 children each from the Mary E. Bennett and Hyde Park Boulevard Schools in Los Angeles.[17] The three groups of elementary school children were composed of first, second, and third year students, whose ages corresponded roughly to the 7, 8, and 9-year levels respectively. Test conditions duplicated those described for Test I, except that observation rooms were not available for the elementary school testing.

Stimuli presented in the three trials of Test II, and the results of the test, are shown in Table 34.

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[17] Data gathered during this testing program in the public schools was used also for an analysis of lipreading performance. The problem of correlation between lipreading ability and the results of psychological testing (available from school records) was the subject of an M. S. thesis submitted to the School of Education, University of Southern California (Barnes, n. d.).

TABLE 34

PERCEPTUAL DISCRIMINATION TEST II

Item No.	PICTURED CHOICES	VERBAL STIMULUS			Correct Choices (%)	
		Trial 1	Trial 2	Trial 3	Total	Preschool
7.	ball - moon	ball	moon	ball	87	87
17.	walk - dog	dog	walk	walk	83	59
10.	bed - book	book	book	bed	80	50
14.	cat - coat	cat	cat	coat	76	45
5.	cake - cow	cow	cow	cake	72	54
15.	boat - phone	phone	phone	boat	72	54
9.	dime - knife	knife	dime	dime	70	54
2.	pie - boy	boy	pie	pie	67	45
16.	house - horse	house	house	horse	65	45
11.	soap - comb	comb	soap	soap	50	27
18.	leaf - teeth	leaf	leaf	teeth	48	32
20.	drum - thumb	drum	drum	thumb	48	18
1.	rope - soap	soap	soap	rope	44	41
6.	leaf - laugh	leaf	laugh	leaf	40	23
12.	thumb - cup	thumb	cup	cup	40	09
3.	mouth - mouse	mouth	mouth	mouse	35	23
19.	soup - soap	soup	soup	soap	35	32
4.	red - dress	red	red	dress	27	09
8.	pin - pig	pig	pig	pin	15	23
13.	two - shoe	two	shoe	shoe	12	04

9. CONCLUSIONS AND IMPLICATIONS:

CLASSIFICATION OF LIPREADING VOCABULARY

Although the experiments described in this report were set up primarily as an attempt to discover the linguistic determinants of perception in oral-visual communication, results of this phase of the investigation have yielded data which are felt to be of possible use in education of the deaf. The knowledge gained experimentally may have limited practical utility, but it does represent a body of information about the visual perceptibility of English speech which can be applied systematically to the selection of graded teaching materials. Findings on the visual discriminability of English phonemes have been used, for example, in compiling a basic word list for training in lipreading.

Proposed Reference Manual

The general purpose of this section, then, is to outline criteria for a systematic classification of English monosyllabic words according to a scale of visual comprehensibility, the ultimate aim being the publication of a practical reference vocabulary which would be of use to teachers in preparing graded lessons for lipreading instruction. Although it is anticipated that such a vocabulary, and its classification will have utility primarily in the training of deafened adults, the materials would comprise a basic reference guide to the lipreadability of English speech, and as such, should prove useful as well to tutors of congenitally deaf and hard of hearing children.[18]

Because the grading of lessons is assumed to be important mainly in beginning lipreading, and because of the stage of research on the basis of which the vocabulary classification was initially proposed--as well as to simplify the classificatory criteria--the present discussion will be limited to a consideration of monosyllabic words. Note, however, that if such an elementary vocabulary were expanded to include a large number of frequently-occurring lexical items, the proposed list would be, in effect, a "Lipreading Dictionary."

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[18] As indicated, a basic word list has already been compiled and partially classified as part of the research activities reported here. Because the manual proposed in this section of the report has met enthusiastic response from a number of people actively engaged in education of the deaf, The John Tracy Clinic has agreed to sponsor completion of the classified vocabulary, and to publish it under the terms of Articles III and IV of the Cooperative Research contract.

Format. An elementary lipreading vocabulary can be set up to consist of an estimated 2500 monosyllabic words of English. The basic listing would be by homophene classes, groups of words which look alike to the lipreader. Within each class, the words could be rated according to lipreading difficulty and frequency of occurrence.

For convenience of reference in lesson planning, and in selecting teaching materials, entries should be indexed alphabetically in conventional English spelling. The visual perceptibility of a word, however, depends not on similarities and differences in conventional spelling, but on the characteristics of its phonetic make-up. For this reason, all entries should also be given in phonemic transcription, to facilitate comparison of forms for any of several teaching purposes.

As an example of the utility of a dual orthography, consider the italicized portions of the following English words:

d*ough*	/ d*ow* /	t*oe*	/ t*ow* /
r*ough*	/ r*əf* /	b*uff*	/ b*əf* /
b*ough*	/ b*aw* /	c*ow*	/ k*aw* /

The phonemic transcriptions (enclosed by diagonals) make immediately obvious the fact that, except for the initial consonant in each case, the words reading down in the left-hand column have identical spelling but different speech components (or "sounds"), while those reading across in each line have different spelling but the same speech components. Because lipreading must be based on speech rather than on writing, it is apparent that a consistent transcription of entries would lend greater usefulness to the materials included.

Ultimately, phonemic symbols are representative of classes of physiological articulation rather than of the acoustic results of these; because the lipreadability of an utterance is dependent partly on the visibility of its articulations, a phonemic transcription would seem to be particularly suited for an organized presentation of any lipreading materials.

Classificatory Criteria

For our purposes, the lipreadability of a word (or the relative lipreading difficulty of a word) is assumed to be a function of the following factors--most of which have been, or can be, established experimentally, or which can be derived logically from an extrapolation of experimental data and the conventions of English usage:

1. Visibility of component articulations. Both absolute and relative visibilities can be determined experimentally for English phonations. The present classification, however, and the initial compilation of a word list were made principally on the basis of Film Test I, which was limited to distinctions among consonant-initial allophones (See Section 4).

In the experiments of the speech perception study, and in setting up classificatory criteria for the proposed manual, it has been found convenient to consider the monosyllabic word as being constituted of three phoneme positions according to a CVC formula, where the syllabic component may be either a simple vowel or a complex vocalic nucleus (diphthong), and where either C-position may be filled by an appropriate consonant (including zero /∅/ or by a consonant cluster of varying complexity.

a. Absolute visibility of articulation. On the basis of test results, it can be said that consonants which involve lip movement (p, b, m, f, v, w, and r) are more perceptible visually than non-labial consonants (č, ǰ, š, ž, y, t, d, n, l, θ, đ, s, z, k, g, h, and ∅), (See Test I).

For purposes of compiling the proposed vocabulary, it has been assumed that syllable-final occurrences of most of these consonants will be visually comparable to the syllable-initial allophones tested in the pilot experiment; (this assumption has not been borne out uniformly, however, for some consonants in some environments (See Test II). The single exception to the extrapolation of data mentioned is the treatment of r-; the high visibility rating attained by this consonant is attributable probably to the lip rounding characteristic of word-initial r-. Even in those dialects of English which include a final -r, however, the labial feature is lacking in this position. On this basis, word-final -r was reclassified with the alveolar consonants for purposes of assessing homophenous items. (Though the formulae adopted for classification of data make it possible to handle the analysis in either of two ways, the -r final has, in most instances, been treated as part of a complex vocalic nucleus in tests involving meaningful words as stimulus units).

b. Relative visibility of articulation. In terms of absolute visibility of phonation, p- and b-, for example, are easier to see than t- (see above); p- and b-, on the other hand, are visually indistinguishable from each other. While p- is likely to be confused with b- in any given position, then, it will not be confused with the less visible t- (cf. Table 4).

2. Number of homophenes

a. Number of articulatory homophenes. This category includes all the words which look alike to the lipreader because of visually equivalent phonations. Because p-, for example, is equivalent visually to only two other English consonants (b- and m-), words including p- in a given phoneme position will be confused only with words which include b- or m- in comparable position. Words which begin with t-, on the other hand, cannot be consistently distinguished, visually, from words which begin with any of fifteen other consonants (see 1-a). As a result, words with p- will be easier to lipread than words with t-, not only because p- is more visible than t- in absolute terms, but also because p-words are likely to confused with fewer other words.

b. Number of functional homophenes

i. Grammatical function. As indicated above, articulatory homophenes of a lexical item are all those words with which it might be confused in lipreading. The number of potential homophenes which are functional, however, may be reduced greatly by the fact that some of these homophenous units will never occur in the same grammatical contexts; such homophenes, consequently, will not actually be confused in speech.

Applying experimental results to possible monosyllabic combinations in English, it can be determined that the word fib, for example, is visually equivalent in phonation to only one other English word, vim.[19] Vim, however, is a noun which does not occur as a verb in English; consequently, when fib functions as a verb, it cannot be confused with vim. In this context, then, fib is distinctive, and will look like no other English word to the lipreader.

Grammatical criteria used here are based on gross distributions which define the major syntactic form classes of English, with no inflectional environments specified.[20] Possibilities for confusion among articulatory homophenes, then, may be considered a function of the number of environments in which homophenous items may co-occur, or are likely to occur. While it might be possible to derive a precise classification of contexts which would make each unit ultimately unique in distribution, a more important characteristic of natural languages is the fact that words are not, in fact, limited to the unique contexts to which they might theoretically be assigned. Ratings for this vocabulary, then, are based on the broader syntactic contexts, and lexical environment is excluded as a criterion of classification (cf. 2-b-ii).

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[19] It should be noted here that most statements of visual discriminability are based only on the consonantal constituents, and that present data do not warrant judgments about the relative visibility of words with different vowels. In the example given above, however, no other possible homophene has been found in tests of vocalic articulation.

[20] The classification followed is that of Fries (1952), which distinguishes four "parts of speech" and fifteen classes of "function words."

ii. Lexical function. A further restriction on the number of functional homophenes of a word is imposed, however, by the semantic compatibility of lexical units in a given utterance. In articulatory terms, for example, the words dog /dɔg/ and cog /kɔg/ are inconsistently distinguishable to the lipreader. However, in the contexts "The --- is chasing the cat" or "The --- of the wheel is broken," the lipreader is not likely to interchange these words in perception. While the expression "The cog is chasing the cat" is theoretically possible in English structure, it is extremely unlikely to occur (except in linguistic examples).

Although it is a factor to be mentioned, then, and one which should be kept in mind by the teacher of lipreading in the preparation of individual classroom materials, lexical context is much too variable to control in any framework such as that proposed here. It represents a problem of individual life experience, differing personal needs, and situational variability; and its solution would seem to lie rather in the talent and experience of the teacher than in any systematic classification of semantic expectancies.

3. Frequency of occurrence

a. Functional homophenes. The number of contexts in which a word is confused with its articulatory homophenes may be reduced still further by the frequency of occurrence of its functional homophenes. Bib, for example, is equivalent visually to two other English words, pip and Bim. (In terms of test results subsequent to those of the pilot study, three additional words, peep, beep, and beam, belong to this class of articulatory homophenes, but the point can be illustrated with the three words initially given).

Because all three words are nouns, bib can be confused in context with either of its two homophenes, pip and Bim. These functional homophenes, however, are comparatively rare in actual occurrences of English speech or writing; they have a combined frequency of only 15 per 18 million words.

Hence, bib is less likely to be confused with its potential homophenes than is the word pip, whose functional homophenes have a frequency rating of 126/18 million.[21]

b. Frequency of the specific word. Frequency of occurrence is important in still another sense to the materials catalogued in the proposed manual. Relative utility of a word for lipreading comprehension depends also on the likelihood of the word's occurrence in speech. Referring again to the examples cited in the preceding section, it is apparent that visual perception of the word bib will be more useful to the student of lipreading than will the comprehension of its relatively infrequent homophenes, pip and Bim; furthermore, in terms of expectancies, it is possible that any prototype of this homophene set will be perceived as the most frequent member.

So that materials can be adapted to various teaching objectives, low-frequency items should be included in a classified vocabulary. For ease of reference to general speech probabilities, however, the entries should be identified and rated in these terms. The teacher may wish to select class materials according to the frequency factor, and modify them to the specialized needs of particular students.

Discussion. Utilizing perceptual units resulting from the experiments in visual speech reception, and applying linguistically-derived criteria, a homophene classification has been set up for a proposed reference vocabulary in lipreading. The question should be raised, perhaps, as to the possible utility of a classified vocabulary for teachers of the deaf--and for students of lipreading. If such a classification should be considered desirable, then the linguistic contribution should be noted. Linguistic techniques will have been shown potentially useful both in basic research and in practical application to problems of education of the deaf.

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[21] Frequency ratings are based on the counts of Thorndike and Lorge (1944). Although there are limitations in such a source for our purposes, it is felt that an approximation of relative frequencies can be achieved, and could have value in practical application of the research data.

APPENDIX A

PRONUNCIATION KEY*

/p/	pill	/t/	till
/b/	bill	/d/	dill
/m/	mill	/n/	nil
/f/	fill	/l/	Lil
/v/	ville	/θ/	thigh
/W/	what	/ð/	thy
/w/	will	/s/	sill
/r/	rill	/z/	zeal
/č/	chill	/k/	kill
/ǰ/	Jill	/g/	gill
/š/	shall	/h/	hill
/ž/	pleasure	∅	ill
/y/	yet		

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*Adapted from Gleason, 1955.

APPENDIX B

Cover Page, Test I

You will be shown a film which was made to test the contrastive values of English consonants for lipreading. You are asked to judge whether or not certain English sounds look alike, i.e., whether pairs of sounds are visibly the same or visibly different.

To aid in classifying and interpreting the results of this study, please provide the personal information requested below. Your answers will be treated as professional confidential material:

1. NAME______________________________
2. SEX: M_____ F _____ 3. AGE______
4. MAILING ADDRESS________________________
5. Is English your native language?______
6. If not, what is your native language?_______________
7. What other languages do you speak or understand?__________
   ____
8. EXTENT OF HEARING LOSS: Normal hearing __________
   Moderate impairment __________
   Severe hearing loss __________
   Totally deaf __________
9. DURATION OF HEARING LOSS: All your life __________
   Number of years __________
10. How long have you practiced lipreading?_________________
11. Do you have normal vision?_________________________
12. COMMENTS (Note: you are invited to state your reactions to the lipreading film, or to add anything to the personal data questionnaire which you feel might be helpful in an analysis of lipreading. Please use the back of this page for this purpose).

INSTRUCTIONS

In the film (which will be presented without sound), the subject is uttering pairs of English nonsense words. Each pair of "words" (or syllables) is alike in the vowel, some pairs differing only in the initial consonant.

A number on the screen precedes each pair of syllables shown; on the attached answer sheets, please check the corresponding number according to whether you think the consonants of each pair are ALIKE or DIFFERENT, i.e., are these the same "words" or different "words".

For example,

> No. 600 appears on the screen, and the subject is shown saying: ta - ta;
> then No. 601 appears and subject says: ta - ka;
> you would then mark the answer sheet as follows:

	ALIKE	DIFF.
600.	X	
601.		X

APPENDIX C

FILM SCRIPT AND TABULATION OF RESPONSES*

TEST I

			VISUAL CONDITION (N = 185)		AUDITORY CONTROL (N = 65)		AUDIO-VISUAL CONTROL (N = 55)	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(22)	1.	ra-wa	84	85	7	55	21	26
(--)	2.	la-la	114	63	63	1	44	10
(37)	3.	ta-sa	112	69	3	61	9	46
(12)	4.	ča-ta	91	90	16	49	4	50
(--)	5.	*ža-*ža	131	54	57	8	52	3
(--)	6.	ta-ta	94	88	63	2	45	10
(68)	7.	da-za	107	78	21	44	18	37
(149)	8.	da-la	42	142	3	62	1	54
(219)	9.	ba-ma	103	80	1	64	12	43
(--)	10.	pa-pa	67	115	50	15	45	10
(26)	11.	pa-ša	1	182	0	65	0	55
(4)	12.	ta-ča	71	112	4	61	1	54
(--)	13.	ǰa-ǰa	164	20	63	2	55	0

*Syllable pairs are numbered according to order of presentation in the film test. Numbers in parentheses refer to reciprocal pairs; e.g., syllable pair No. 1 is ra - wa and pair No. 22 is wa - ra. Where the sum of the responses to a given pair does not equal the N listed for the group, the discrepancy indicates omissions.

			VISUAL		AUDITORY		AUDIO-VISUAL	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(223)	14.	*ža-aa	1	184	0	65	2	53
(69)	15.	ka-ha	77	108	19	45	9	46
(209)	16.	ka-ča	39	144	0	64	0	55
(42)	17.	aa-ba	14	170	0	64	0	55
(95)	18.	ka-aa	118	67	0	64	2	53
(73)	19.	wa-la	5	179	44	20	0	55
(85)	20.	ba-da	3	182	47	17	0	55
(87)	21.	za-va	6	178	14	50	0	55
(1)	22.	wa-ra	63	121	55	9	38	17
(211)	23.	ša-sa	29	156	1	64	1	54
(132)	24.	da-va	9	175	55	10	7	48
(222)	25.	fa-aa	10	175	0	65	1	54
(11)	26.	ša-pa	5	179	0	65	0	55
(49)	27.	sa-ka	31	154	0	65	0	55
(165)	28.	ra-za	12	173	2	63	3	52
(41)	29.	ra-aa	13	172	0	65	0	55
(128)	30.	fa-ša	4	179	0	65	0	55
(117)	31.	ša-ta	149	35	0	65	2	53
(96)	32.	ka-fa	8	177	1	64	1	54
(203)	33.	ya-ča	28	156	0	65	1	54

			VISUAL		AUDITORY		AUDIO-VISUAL	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(181)	34.	da-ta	148	36	0	65	4	51
(76)	35.	ta-ka	48	137	1	64	2	53
(164)	36.	ša-ča	169	14	15	50	17	38
(3)	37.	sa-ta	126	59	0	65	1	54
(155)	38.	pa-ta	10	173	2	63	1	54
(130)	39.	aa-la	54	131	0	65	3	52
(110)	40.	ka-pa	11	174	7	58	3	52
(29)	41.	aa-ra	17	166	0	65	0	55
(17)	42.	ba-aa	15	169	0	65	0	55
(59)	43.	va-wa	15	170	20	45	4	51
(151)	44.	da-ha	6	178	0	65	0	55
(--)	45.	ša-ša	140	45	65	0	44	11
(--)	46.	sa-sa	144	38	60	5	53	2
(176)	47.	aa-za	13	169	1	64	2	53
(91)	48.	da-θa	158	26	10	55	23	32
(27)	49.	ka-sa	66	118	1	64	2	53
(226)	50.	ya-*ža	46	139	1	64	3	52
(178)	51.	za-sa	140	43	0	65	7	48
(99)	52.	*ža-da	160	24	0	65	4	51
(114)	53.	Wa-ša	1	183	1	64	1	54

			VISUAL		AUDITORY		AUDIO-VISUAL	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(199)	54.	ha-wa	10	173	1	64	0	55
(159)	55.	ra-na	6	178	41	24	6	49
(213)	56.	ra-ta	23	161	0	65	1	54
(144)	57.	ša-za	41	143	0	65	4	51
(74)	58.	ša-ya	71	114	0	64	1	54
(43)	59.	wa-va	10	175	24	41	6	49
(170)	60.	da-ra	22	161	13	52	2	53
(77)	61.	đa-aa	14	170	0	65	0	54
(98)	62.	sa-da	134	51	0	65	3	52
(150)	63.	ra-fa	41	143	1	64	0	55
(108)	64.	ra-la	10	174	26	39	4	51
(215)	65.	va-aa	2	183	0	65	1	54
(106)	66.	aa-ga	108	77	1	64	3	52
(143)	67.	da-đa	49	134	22	43	14	40
(7)	68.	za-đa	79	106	20	44	21	34
(15)	69.	ha-ka	66	118	10	54	9	46
(82)	70.	za-*ža	38	146	4	61	3	52
(191)	71.	pa-ba	83	101	2	63	2	53
(141)	72.	fa-Wa	14	171	8	57	0	55
(19)	73.	la-wa	3	182	15	50	2	53

			VISUAL		AUDITORY		AUDIO-VISUAL	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(58)	74.	ya-ša	70	115	0	65	0	55
(112)	75.	θa-ta	54	131	0	65	3	52
(35)	76.	ka-ta	119	62	8	57	12	43
(61)	77.	aa-đa	35	147	0	65	2	53
(220)	78.	ga-da	97	85	21	44	16	39
(--)	79.	đa-đa	133	51	52	13	42	13
(201)	80.	ǰa-*ža	145	40	36	29	40	15
(94)	81.	wa-ba	7	178	3	62	0	55
(70)	82.	*ža-za	51	133	0	65	3	52
(116)	83.	aa-ta	13	171	0	65	1	54
(160)	84.	aa-θa	19	165	0	65	1	54
(20)	85.	da-ba	8	176	1	64	3	52
(119)	86.	ga-ha	59	125	0	65	3	52
(21)	87.	va-za	16	169	9	56	1	54
(--)	88.	Wa-Wa	168	16	54	11	49	6
(--)	89.	ra-ra	147	37	62	3	51	4
(133)	90.	pa-fa	33	152	6	59	2	53
(48)	91.	θa-đa	127	58	5	60	2	53
(190)	92.	Wa-wa	167	16	15	50	16	39
(111)	93.	pa-ma	116	68	3	62	2	53

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(81) 94. ba-wa	13	172	1	64	1	54
(18) 95. aa-ka	35	150	0	65	1	54
(32) 96. fa-ka	16	168	0	65	0	55
(192) 97. ǰa-aa	0	184	0	65	0	55
(62) 98. da-sa	104	79	1	64	2	53
(52) 99. da-*ža	99	86	0	65	2	53
(212) 100. aa-sa	14	170	0	65	0	55
(200) 101. sa-θa	93	92	24	41	18	37
(126) 102. va-ba	38	147	36	29	16	39
(156) 103. ča-ǰa	168	17	4	61	3	52
(--) 104. na-na	88	97	61	4	42	13
(138) 105. pa-Wa	9	176	11	54	2	53
(66) 106. ga-aa	6	179	0	65	1	54
(158) 107. na-da	145	39	0	65	3	52
(64) 108. la-ra	8	177	35	30	6	49
(162) 109. wa-ya	1	184	56	9	2	53
(40) 110. pa-ka	8	177	0	65	0	55
(93) 111. ma-pa	129	56	2	63	8	47
(75) 112. ta-θa	60	123	27	38	9	46
(207) 113. da-pa	3	182	0	65	1	54

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(53) 114. ša-Wa	0	185	1	64	0	55
(--) 115. fa-fa	135	50	53	12	45	10
(83) 116. ta-aa	3	181	0	65	1	54
(31) 117. ta-ša	105	79	0	65	1	54
(161) 118. ma-na	11	174	49	16	12	43
(86) 119. ha-ga	90	94	2	63	2	53
(168) 120. ya-sa	108	77	0	65	0	55
(142) 121. aa-wa	14	171	0	65	1	54
(--) 122. ba-ba	162	21	64	1	49	6
(129) 123. aa-pa	30	155	12	53	1	54
(189) 124. ra-ya	18	167	56	9	8	47
(184) 125. ča-aa	20	165	0	65	0	55
(102) 126. ba-va	10	175	11	54	5	50
(--) 127. wa-wa	171	14	60	5	52	3
(30) 128. ša-fa	4	180	0	65	0	55
(123) 129. pa-aa	96	89	1	64	2	53
(39) 130. la-aa	20	164	0	65	3	52
(146) 131. ka-ga	84	101	0	65	3	52
(24) 132. va-da	85	99	50	15	27	27
(90) 133. fa-pa	8	175	15	50	1	54

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(196) 134. za-da	129	55	3	62	6	49
(63) 135. sa-ra	11	174	0	65	0	55
(154) 136. sa-*ža	66	119	0	65	2	53
(194) 137. θa-da	59	125	1	64	5	50
(105) 138. Wa-pa	11	174	1	64	0	55
(140) 139. ha-Wa	14	171	0	65	0	55
(139) 140. Wa-ha	9	176	0	65	0	55
(72) 141. Wa-fa	5	179	1	64	0	55
(121) 142. wa-aa	11	174	0	65	0	55
(67) 143. ða-da	61	123	0	65	2	53
(57) 144. za-ša	93	92	0	65	2	53
(195) 145. ya-ga	159	26	1	64	11	44
(131) 146. ga-ka	153	32	0	65	3	52
(173) 147. aa-ma	19	165	0	65	0	55
(221) 148. da-aa	6	179	0	65	0	55
(8) 149. la-da	102	82	1	64	5	50
(63) 150. fa-ra	47	136	0	65	1	54
(44) 151. ha-da	125	56	1	64	1	54
(--) 152. ya-ya	28	156	57	7	40	15
(180) 153. aa-na	37	145	0	65	2	53

			VISUAL		AUDITORY		AUDIO-VISUAL	
			ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(136)	154.	*ža-sa	78	106	0	65	1	54
(38)	155.	ta-pa	5	180	2	63	1	54
(103)	156.	ǰa-ča	146	39	13	52	16	39
(--)	157.	za-za	138	46	59	6	46	8
(107)	158.	da-na	31	154	0	65	7	48
(55)	159.	na-ra	5	180	9	56	0	55
(84)	160.	θa-aa	3	182	0	65	1	54
(118)	161.	na-ma	1	184	38	27	6	49
(109)	162.	ya-wa	2	183	28	37	5	49
(135)	163.	ra-sa	11	174	0	65	1	53
(36)	164.	ča-ša	159	25	25	40	26	28
(28)	165.	za-ra	16	169	6	59	1	53
(216)	166.	aa-ša	12	172	0	65	0	54
(218)	167.	ǰa-da	150	35	1	64	3	51
(120)	168.	sa-ya	71	111	0	65	1	53
(228)	169.	ya-ǰa	78	107	1	64	5	49
(60)	170.	ra-da	19	165	0	65	1	53
(206)	171.	ša-*ža	171	13	2	63	2	52
(179)	172.	ra-ga	10	172	1	64	2	52
(147)	173.	ma-aa	4	180	0	65	1	53

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(--) 174. ga-ga	128	55	63	2	50	4
(188) 175. fa-va	143	39	5	60	7	47
(47) 176. za-aa	21	162	0	65	0	55
(--) 177. ča-ča	167	17	51	14	36	19
(51) 178. sa-za	139	45	3	62	5	50
(172) 179. ga-ra	4	181	2	63	1	54
(153) 180. na-aa	24	160	0	65	1	54
(34) 181. ta-da	138	47	0	65	2	53
(--) 182. ka-ka	133	52	61	4	48	7
(210) 183. ya-aa	14	170	1	64	0	55
(125) 184. aa-ča	14	169	1	64	0	55
(--) 185. da-da	139	45	61	4	51	4
(197) 186. aa-ha	57	127	6	59	18	37
(--) 187. va-va	122	62	56	9	44	11
(175) 188. va-fa	117	67	1	64	4	51
(124) 189. ya-ra	15	170	44	21	2	53
(92) 190. wa-Wa	149	35	3	62	9	46
(71) 191. ba-pa	134	50	3	62	4	51
(97) 192. aa-ǰa	10	172	0	65	0	55
(198) 193. Wa-aa	4	180	0	65	0	55

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(137) 194. da-θa	62	122	1	64	5	50
(145) 195. ga-ya	103	82	0	65	10	45
(134) 196. da-za	130	54	1	64	3	52
(186) 197. ha-aa	52	133	0	65	3	52
(193) 198. aa-Wa	4	181	0	65	0	55
(54) 199. wa-ha	5	179	0	65	1	54
(101) 200. θa-sa	78	107	12	53	29	25
(80) 201. *ža-ǰa	153	31	12	53	12	43
(204) 202. ya-la	48	137	17	48	14	41
(33) 203. ča-ya	33	152	0	65	3	52
(202) 204. la-ya	126	59	17	48	21	34
(--) 205. ma-ma	117	66	57	8	45	10
(171) 206. *ža-ša	153	32	4	61	5	50
(113) 207. pa-da	5	180	0	65	1	54
(227) 208. ta-na	80	103	0	65	3	52
(16) 209. ča-ka	49	134	0	65	0	55
(183) 210. aa-ya	73	111	0	65	1	54
(23) 211. sa-ša	59	125	0	65	1	54
(100) 212. sa-aa	3	181	0	65	1	54
(56) 213. ta-ra	4	181	1	64	1	54

	VISUAL		AUDITORY		AUDIO-VISUAL	
	ALIKE	DIFF.	ALIKE	DIFF.	ALIKE	DIFF.
(--) 214. ha-ha	108	76	60	5	45	10
(65) 215. aa-va	6	177	0	65	1	54
(166) 216. ša-aa	7	178	0	65	0	55
(225) 217. la-na	82	101	19	46	15	40
(167) 218. da-ǰa	86	98	0	65	0	55
(9) 219. ma-ba	119	66	0	65	5	50
(78) 220. da-ga	95	89	28	37	21	34
(148) 221. aa-da	101	83	0	65	1	53
(25) 222. aa-fa	21	163	0	65	0	54
(14) 223. aa-*ža	12	172	0	65	0	55
(--) 224. θa-θa	142	43	47	18	39	16
(217) 225. na-la	113	72	26	39	22	33
(50) 226. *ža-ya	34	151	0	65	2	53
(208) 227. na-ta	126	59	0	65	1	54
(169) 228. ǰa-ya	49	134	0	64	2	53
(--) 229. aa-aa	96	89	64	1	49	6

APPENDIX D

INDEX OF PERCEPTUAL DIFFERENCE*
TEST I

CONSONANT PAIR	STIMULUS CONDITION		
	Visual	Auditory	Audio-Visual
p - b	-.35	1.84	1.78
p - m	-.66	1.84	1.62
p - f	1.55	1.36	1.88
p - W	1.78	1.62	1.92
p - š	1.91	2.00	2.00
p - t	1.82	1.88	1.92
p - d	1.90	2.00	1.92
p - k	1.80	1.78	1.90
p - ∅	.64	1.60	1.88
b - m	-.41	1.96	1.38
b - v	1.48	.56	1.24
b - w	1.78	1.86	1.96
b - d	1.87	.50	1.90
b - ∅	1.67	1.98	2.00

*Perceptual difference ratings listed here were derived from combined reciprocal responses--i.e., from the relative frequency of "different" responses to syllable pairs presented in both possible sequences. As a result, phonemically identical pairs are not included in this analysis.

	Visual	Auditory	Audio-Visual
m - n	1.86	-.66	1.34
m - ∅	1.74	2.00	1.94
f - v	-.83	1.80	1.70
f - W	1.78	1.72	2.00
f - r	1.03	1.96	1.96
f - š	1.90	2.00	2.00
f - k	1.74	1.96	1.96
f - ∅	1.67	2.00	1.94
v - w	1.74	.64	1.64
v - ð	.97	-1.24	.74
v - z	1.75	1.27	1.96
v - ∅	1.91	2.00	1.92
W - w	-1.43	1.44	1.10
W - š	1.98	1.92	1.96
W - h	1.74	2.00	2.00
W - ∅	1.91	2.00	2.00
w - r	.32	.03	-.29
w - y	1.96	-.58	1.72
w - l	1.90	.17	1.92

	Visual	Auditory	Audio-Visual
w - h	1.82	1.96	1.96
w - ∅	1.72	2.00	1.96
r - y	1.64	-1.08	1.62
r - t	1.71	1.96	1.92
r - d	1.54	1.60	1.86
r - n	1.87	.46	1.78
r - l	1.81	.12	1.64
r - s	1.76	2.00	1.94
r - z	1.68	1.76	1.84
r - g	1.84	1.90	1.87
r - ∅	1.67	2.00	2.00
č - ǰ	-1.40	1.48	1.32
č - š	-1.56	.78	.42
č - y	1.33	2.00	1.86
č - t	.23	1.38	1.80
č - k	1.02	1.98	2.00
č - ∅	1.61	1.96	2.00
ǰ - *ž	-1.22	.54	.10
ǰ - y	.61	1.94	1.72
ǰ - d	-.56	1.96	1.88
ǰ - ∅	1.87	2.00	2.00
š - *ž	-1.51	1.82	1.73
š - y	.48	1.98	1.96

	Visual	Auditory	Audio-Visual
š - t	-.76	2.00	1.88
š - s	1.04	1.96	1.92
š - z	.55	2.00	1.78
š - ∅	1.78	2.00	1.98
*ž - y	1.14	1.96	1.82
*ž - d	-.80	2.00	1.78
*ž - s	.43	2.00	1.88
*ž - z	1.02	1.88	1.80
*ž - ∅	1.84	2.00	1.92
y - l	.12	.96	.74
y - s	.06	2.00	1.94
y - g	-.84	1.96	1.24
y - ∅	1.05	1.96	1.96
t - d	-1.11	2.00	1.78
t - n	-.23	2.00	1.86
t - θ	.77	1.16	1.58
t - s	-.60	1.89	1.64
t - k	.17	1.72	1.48
t - ∅	1.81	2.00	1.92
d - n	.09	2.00	1.64
d - l	.43	1.86	1.78
d - θ	.69	1.92	1.64
d - ð	.79	1.32	1.40

	Visual	Auditory	Audio-Visual
d - s	-.57	1.96	1.82
d - z	-.81	1.86	1.68
d - g	-.09	.50	.66
d - h	.55	1.96	1.96
d - ∅	.84	2.00	1.94
n - l	-.11	.62	.66
n - ∅	1.32	2.00	1.88
l - ∅	1.20	2.00	1.80
θ - đ	-1.09	1.54	1.08
θ - s	.16	.90	.26
θ - ∅	1.75	2.00	1.92
đ - z	-.02	.73	.58
đ - ∅	1.44	2.00	1.90
s - z	-1.04	1.90	1.56
s - k	.94	1.96	1.92
s - ∅	1.80	2.00	1.96
z - ∅	1.61	1.96	1.92
k - g	-.56	2.00	1.80
k - h	.44	1.08	1.36
k - ∅	.34	1.98	1.88
g - h	.38	1.94	1.82
g - ∅	.78	1.96	1.86
h - ∅	.82	1.82	1.24

APPENDIX E-1

RANK ORDER OF VISUAL DIFFERENCE
TEST I

Contrastive
(1.98 to 1.44)

1. W - š
2. w - y
3. p - š
v - ∅
W - ∅
4. p - d
f - š
w - l
5. b - d
r - n
ǰ - ∅
6. m - n
7. r - g
*ž - ∅
8. p - t
w - h
9. r - l
t - ∅
10. p - k
s - ∅
11. p - W
b - w
f - W
š - ∅
12. r - s
13. v - z
θ - ∅
14. m - ∅
f - k
v - w
W - h
15. w - ∅
16. r - t
17. r - z
18. b - ∅
f - ∅
r - ∅
19. r - y
20. č - ∅
z - ∅
21. p - f
22. r - d
23. b - v
24. đ - ∅

Similar
(1.33 to .06)

25. č - y
26. n - ∅
27. l - ∅
28. *ž - y
29. y - ∅
30. š - s
31. f - r
32. č - k
*ž - z
33. v - đ
34. s - k
35. d - ∅
36. h - ∅
37. d - đ
38. g - ∅
39. t - θ
40. d - θ
41. p - ∅
42. ǰ - y
43. š - z
d - h
44. š - y
45. k - h
46. *ž - s
d - l
47. g - h
48. k - ∅
49. w - r
50. č - t
51. t - k
52. θ - s
53. y - l
54. d - n
55. y - s

Equivalent
(-.02 to -1.56)

56. đ - z
57. d - g
58. n - l
59. t - n
60. p - b
61. b - m
62. ǰ - d
k - g
63. d - s
64. t - s
65. p - m
66. š - t
67. *ž - d
68. d - z
69. f - v
70. y - g
71. s - z
72. θ - đ
73. t - d
74. ǰ - *ž
75. č - ǰ
76. W - w
77. š - *ž
78. č - š

APPENDIX E-2

RANK ORDER OF AUDITORY DIFFERENCE
TEST I

Contrastive
(2.00 to 1.38)

1. p - š
p - d
m - ∅
f - š
f - ∅
v - ∅
W - h
W - ∅
w - ∅
r - s
r - ∅
č - y
ǰ - ∅
š - t
š - z
š - ∅
*ž - d
*ž - s
*ž - ∅
y - s
t - d
t - n
t - ∅
d - n
d - ∅
n - ∅
l - ∅
θ - ∅
đ - ∅
s - ∅
k - g
2. b - ∅
č - k
š - y
k - ∅
3. b - m
f - r
f - k
w - h
r - t
č - ∅
ǰ - d
š - s
*ž - y
y - g
y - ∅
d - s
d - h
s - k
z - ∅
g - ∅
4. ǰ - y
g - h
5. W - š
d - θ
6. r - g
s - z
7. t - s
8. p - t
*ž - z
9. b - w
d - l
d - z
10. p - b
p - m
11. š - *ž
h - ∅
12. f - v
13. p - k
14. r - z
15. f - W
t - k
16. p - W
17. p - ∅
r - d
18. θ - đ
19. č - ǰ
20. W - w
21. č - t

Similar
(1.36 to .03)

22. p - f
23. d - đ
24. v - z
25. t - θ
26. k - h
27. y - l
28. θ - s
29. č - š
30. đ - z
31. v - w
32. n - l
33. b - v
34. ǰ - *ž
35. b - d
d - g
36. r - n
37. w - l
38. r - l
39. w - r

Equivalent
(-.58 to -1.24)

40. w - y
41. m - n
42. r - y
43. v - đ

APPENDIX E-3

RANK ORDER OF AUDIO-VISUAL DIFFERENCE
TEST I

Contrastive
(2.00 to 1.38)

1. p - š
b - ∅
f - W
f - š
W - h
W - ∅
r - ∅
č - k
č - ∅
ǰ - ∅
2. š - ∅
3. b - w
f - r
f - k
v - z
W - š
w - h
w - ∅
š - y
y - ∅
d - h
s - ∅
4. m - ∅
f - ∅
r - s
y - s
d - ∅
5. p - W
p - t
p - d
v - ∅
w - l
r - t
š - s
*ž - ∅
t - ∅
θ - ∅
s - k
z - ∅
6. p - k
b - d
đ - ∅
7. p - f
p - ∅
ǰ - d
š - t
*ž - s
n - ∅
k - ∅
8. r - g
9. r - d
č - y
t - n
g - ∅
10. r - z
11. *ž - y
d - s
g - h
12. č - t
*ž - z
l - ∅
k - g
13. p - b
r - n
š - z
*ž - d
t - d
d - l
14. š - *ž
15. w - y
ǰ - y
16. f - v
17. d - z
18. v - w
r - l
t - s
d - n
d - θ
19. p - m
r - y
20. t - θ
21. s - z
22. t - k
23. d - đ
24. b - m

Similar
(1.36 to .10)

25. k - h
26. m - n
27. č - ǰ
28. b - v
y - g
h - ∅
29. W - w
30. θ - đ
31. v - đ
y - l
32. d - g
n - l
33. đ - z
34. č - š
35. θ - s
36. ǰ - *ž

Equivalent
(-.29)

37. w - r

APPENDIX F

Cover Page, Test II

Studies in Visual Communication
Linguistics Project

FORM II-v

____

Test II-v-________

G________ S________

________ Please do not write above this line ________

Your co-operation is requested in a project designed to improve techniques for teaching lipreading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested below. Your answers will be kept confidential.

1. Name____

2. Sex: M______ F______

3. Age________

4. Mailing address________________________________

5. Is English your native language?____ If not, what is?____________

6. What other languages do you speak or understand?____________

7. Do you have a hearing loss?_____ If yes, please indicate degree and duration:

   Hard of hearing ______
   Severely deaf ______
   Profoundly deaf ______

   Since birth ______
   Number of years ______

8. Have you practiced lipreading?______ If yes, how long?__________

9. Do you have normal vision?______________________________

10. COMMENTS: You are invited to state your reactions to the film or to add anything to this questionnaire which you feel might be helpful in an analysis of lipreading. You may use the back of this page for these remarks.

INSTRUCTIONS

You are about to see a silent film which was made to test how easily certain words may be identified by lipreading. In the film, a speaker is pronouncing a series of one-syllable English words, each of which is numbered. In the space following the corresponding number on the answer sheet, please write down the word you think was pronounced. There is ample time between words for you to write your answer, and additional time is provided when you must turn the page. Please pay attention to the printed instructions at the beginning of the film. We will be glad to answer any questions you may have about the project after the film has been shown.

APPENDIX G

Script for Film Test II

1. squeeze
2. grass
3. price
4. song
5. witch
6. wreck
7. chief
8. boot
9. glass
10. spree
11. deer
12. sign
13. fog
14. wick
15. glide
16. cone
17. rule
18. door
19. shred
20. speed
21. foot
22. rain
23. rose
24. fate
25. fig
26. leech
27. load
28. sphere
29. head
30. thing
31. sneeze
32. roof
33. weed
34. gear
35. top
36. bus
37. wool
38. thug
39. cue
40. sum
41. prose
42. slide
43. pot
44. wheat
45. spool
46. date
47. gum
48. rouge
49. pose
50. zoo
51. twitch
52. breed
53. shoe
54. fight
55. nap
56. goose
57. hall
58. scheme
59. freight
60. chin
61. dog
62. siege
63. bid
64. mule
65. tweed
66. seer
67. cot
68. sieve
69. tube
70. ear
71. fawn
72. butte
73. spine
74. tape
75. bet
76. year
77. king
78. loom
79. chum
80. gas

81. seed
82. bait
83. wake
84. flight
85. soup
86. loaf
87. shawl
88. splice
89. hue
90. seam
91. ditch
92. bat
93. cane
94. book
95. stream
96. voice
97. quack
98. thought
99. wing
100. hooch
101. wreath
102. lick
103. thong
104. tin
105. dough
106. brute
107. niece
108. bloom
109. dream
110. coat
111. stool
112. prize
113. shed
114. coal
115. thread
116. ring
117. fudge
118. fin
119. quake
120. kick
121. tug
122. boy
123. grain
124. bite
125. reed
126. fuel
127. rug
128. cake
129. pile
130. key
131. blight
132. tab
133. tooth
134. bout
135. cream
136. tool
137. fear
138. walk
139. fright
140. click
141. gin
142. yawn
143. code
144. talk
145. train
146. you
147. type
148. boss
149. room
150. feed
151. shop
152. broom
153. beet
154. dawn
155. lamb
156. team
157. boat
158. light
159. cop
160. bill

161. school

162. ream

163. trick

164. owl

165. queen

166. leash

167. bin

168. throng

169. wig

170. ski

171. oil

172. suite

173. eye

174. ridge

175. scream

176. bread

177. bit

178. fool

179. thief

180. cheer

181. thumb

182. car

183. reef

184. shin

185. cow

186. root

187. wrong

188. pool

189. chalk

190. steam

191. judge

192. call

193. hill

194. job

195. leaf

196. hood

197. phone

198. smear

APPENDIX H

Data Sheet, Test II

Total Responses:	Total Rejects: 0· AS: P:	Total different words guessed:

p_____
b_____
m_____
w_____
r_____
f _____
v_____
θ_____
đ_____
t _____
d_____
n_____
l _____
s_____
z_____
č_____
ǰ_____

pr_____
pl_____
br_____
bl_____
fr_____
fl_____
θr_____
θw_____
tw_____
tr_____
dr_____

py_____
by_____
my_____
fy_____
vy_____

sp_____
spr_____
spl_____
sm_____
sw_____
sf_____
st_____
str_____
sn_____
sl_____

iy_____
i_____
ir_____
ey_____
e_____
er_____
ä_____
ə_____
ər_____
ay_____
a_____
aw_____
ar_____
uw_____
u_____
ur_____
ow_____

p_____
b_____
m_____
f_____
v_____
θ_____
đ_____
t_____
d_____
n_____
l_____
s_____
z_____
č_____
ǰ_____

(bottom half of data sheet continued on next page)

Total Responses:	Total Rejects: O· AS: P:			Total different words guessed:	
š____	šr____			ɔy____	š____
y____				ɔ____	ž____
k____	kw____	ky____	sk____	ɔr____	k____
g____	kr____		skw____		g____
h____	kl____	hy____	skr____		ŋ____
∅____	gr____				∅____
	gl____				CC+____
	hw____				CC-____
TOTAL:					

APPENDIX I

PERCENTAGE OF CORRECT RESPONSES FULL-FACE AND PROFILE VIEWS

TEST II-v

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
1. skwiyz	.02	.12	.60	.66	.05	.14	.88	.92
2. gräs	.29	.39	.50	.46	.49	.52	.85	.90
3. prays	.38	.26	.59	.59	.47	.43	.85	.89
4. sɔŋ	.34	.28	.65	.54	.17	.10	.91	.92
5. wič	.57	.58	.88	.90	.56	.55	.86	.84
6. rek	.34	.42	.20	.16	.06	.05	.84	.85
7. čiyf	.46	.39	.46	.39	.62	.49	.89	.87
8. buwt	.39	.24	.41	.43	.20	.10	.55	.60
9. gläs	.20	.15	.61	.52	.50	.44	.77	.76
10. spriy∅	.85	.82	.07	.12	.11	.25	.70	.78
11. dir∅	.18	.08	.47	.39	.72	.56	.64	.80
12. sayn	.61	.55	.16	.27	.16	.10	.80	.82
13. fɔg	.82	.82	.55	.69	.33	.47	.86	.93
14. wik	.66	.71	.13	.27	.02	.10	.92	.95
15. glayd	.05	.08	.46	.54	.09	.08	.92	.91
16. kown	.13	.24	.96	.95	.18	.01	.90	.90

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
17. ruwl	.34	.39	.55	.59	.38	.53	.72	.77
18. dɔr	.13	.12	.54	.61	.78	.92	.87	.89
19. šred	.01	.02	.03	.05	.03	.01	.74	.76
20. spiyd	.81	.88	.68	.64	.16	.19	.74	.80
21. fut	.90	.82	.36	.43	.39	.47	.90	.87
22. reyn	.29	.50	.35	.46	.28	.29	.92	.92
23. rowz	.79	.84	.88	.81	.46	.52	.68	.75
24. feyt	.84	.90	.45	.39	.22	.22	.96	.97
25. fig	.67	.82	.15	.11	.04	.03	.86	.84
26. liyč	.46	.56	.57	.56	.61	.47	.70	.65
27. lowd	.39	.49	.47	.34	.11	.05	.71	.70
28. sfir	.40	.50	.57	.57	.66	.77	.44	.46
29. hed	.67	.63	.10	.14	.13	.21	.90	.88
30. θiŋ	.26	.55	.21	.50	.12	.19	.94	.93
31. sniyz	.02	.06	.24	.22	.08	.12	.84	.90
32. ruwf	.81	.81	.93	.93	.85	.82	.89	.91
33. wiyd	.72	.78	.18	.22	0	.02	.89	.96
34. gir∅	0	.01	.68	.70	.91	.84	.74	.79
35. tap	.31	.30	.92	.95	.99	.98	1.00	1.00
36. bəs	.56	.48	.32	.25	.52	.44	.92	.75

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
37. wul	.91	.86	.58	.52	.58	.57	.92	.92
38. θəg	.28	.59	.35	.26	.05	.08	.90	.92
39. kyuw∅	.02	.03	.94	.94	.88	.92	.90	.95
40. səm	.25	.20	.34	.35	.18	.24	.89	.87
41. prowz	.07	.05	.86	.88	.26	.15	.91	.85
42. slayd	.32	.32	.43	.45	.25	.28	.83	.81
43. pat	.23	.29	.60	.66	.20	.22	.93	.95
44. hwiyt	.22	.23	.12	.13	.41	.40	.90	.94
45. spuwl	.84	.80	.90	.87	.55	.55	.90	.90
46. deyt	.07	.09	.43	.35	.35	.24	.90	.91
47. gəm	∅	∅	.80	.79	.06	.14	.95	.95
48. ruwž	.57	.56	.58	.57	.29	.27	.81	.84
49. powz	.23	.17	.88	.85	.15	.14	.88	.76
50. zuw∅	.01	∅	.95	.96	.61	.63	.92	.98
51. twič	.06	.02	.81	.92	.69	.73	.86	.81
52. briyd	.78	.75	.07	.04	.16	.09	.91	.89
53. šuw∅	.47	.48	.93	.93	.82	.77	.89	.94
54. fayt	.88	.86	.71	.55	.75	.62	.97	.96
55. na̋p	.07	.02	.85	.85	.70	.84	.82	.88
56. guws	.04	.06	.74	.84	.31	.39	.76	.88

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
57. hɔl	.31	.44	.81	.85	.85	.92	.97	.96
58. skiym	.07	.05	.30	.48	.07	.12	.81	.81
59. freyt	.75	.76	.20	.20	.64	.64	.92	.97
60. čin	.49	.55	.21	.24	.05	.11	.81	.79
61. dɔg	.24	.19	.62	.70	.19	.18	.92	.93
62. siyǰ	.22	.23	.44	.40	.03	.01	.64	.65
63. bid	.50	.50	.37	.30	.03	.01	.93	.95
64. myuwl	.03	.06	.68	.76	.15	.28	.83	.87
65. twiyd	.13	.12	.26	.19	∅	.01	.79	.80
66. sir∅	.40	.47	∅	.02	.33	.44	.74	.75
67. kat	.03	.02	.70	.67	.76	.67	.99	.93
68. siv	.41	.31	.45	.62	.02	.05	.80	.83
69. tuwb	.13	.18	.96	.96	.05	.17	.89	.88
70. ∅ir∅	.11	.13	.65	.68	.94	.87	.77	.87
71. fɔn	.88	.71	.74	.82	.01	∅	.78	.83
72. byuwt	∅	.01	.64	.81	.44	.42	.80	.78
73. spayn	.53	.54	.64	.48	.08	.07	.83	.80
74. teyp	.06	.02	.01	.04	.70	.77	.92	.88
75. bet	.51	.45	.07	.14	.35	.15	.89	.83

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
76. yirø	.35	.29	.04	.05	.71	.63	.92	.90
77. kiŋ	.20	.13	.11	.07	.01	ø	.84	.87
78. luwm	.25	.26	.94	.92	.08	.11	.86	.82
79. čəm	.15	.16	.48	.41	ø	ø	.89	.86
80. gäs	.02	.02	.84	.78	.22	.23	.96	.93
81. siyd	.57	.61	.30	.52	.04	.05	.84	.88
82. beyt	.48	.54	.32	.44	.39	.28	.97	.96
83. weyk	.63	.71	.64	.64	.04	.09	.95	.95
84. flayt	.35	.35	.33	.36	.56	.59	.93	.92
85. suwp	.48	.45	.91	.89	.87	.89	.85	.86
86. lowf	.54	.45	.55	.46	.85	.82	.74	.74
87. šɔl	.42	.40	.64	.72	.70	.74	.83	.90
88. splays	.35	.29	.37	.29	.47	.55	.76	.73
89. hyuwø	.05	.06	.96	.96	.84	.84	.93	.96
90. siym	.10	.09	.26	.36	.01	ø	.86	.89
91. dič	.12	.50	.31	.39	.68	.75	.73	.67
92. bät	.44	.36	.79	.80	.41	.45	.93	.91
93. keyn	.25	.26	.30	.33	.17	.18	.82	.86
94. buk	.69	.71	.59	.77	.48	.61	.97	.98

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
95. striym	.21	.31	.18	.09	.37	.33	.86	.87
96. vɔys	.15	.14	.17	.14	.50	.48	.90	.81
97. kwäk	.15	.23	.44	.46	.40	.39	.81	.78
98. θɔt	.94	.94	.92	.92	.89	.89	.97	.96
99. wiŋ	.61	.56	.10	.16	.02	.04	.89	.95
100. huwč	.56	.51	.69	.72	.21	.29	.91	.83
101. riyθ	.03	.04	.03	.01	.03	.03	.93	.96
102. lik	.43	.40	.52	.65	.25	.29	.89	.88
103. θɔŋ	.76	.79	.79	.83	.09	.11	.92	.98
104. tin	.06	.10	.48	.48	.05	.14	.91	.84
105. dow∅	.04	.06	.77	.74	.75	.81	.94	.95
106. bruwt	.07	.08	.41	.49	.17	.18	.83	.90
107. niys	.01	.05	.17	.16	.22	.31	.84	.89
108. bluwm	.51	.40	.75	.87	.32	.35	.72	.70
109. driym	.03	.09	.20	.13	.23	.31	.89	.86
110. kowt	.33	.34	.89	.84	.27	.18	.85	.79
111. stuwl	.10	.09	.87	.83	.46	.25	.90	.88
112. prayz	.41	.27	.81	.82	.18	.07	.95	.96
113. šed	.49	.45	.20	.29	.14	.10	.87	.83

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
114. kowl	.22	.33	.92	.97	.33	.35	.95	.96
115. θred	.59	.78	.44	.54	.27	.37	.88	.89
116. riŋ	.38	.61	.16	.23	.08	.18	.91	.96
117. fəǰ	.43	.56	.11	.08	.10	.06	.96	.91
118. fin	.69	.71	.21	.22	.07	.07	.96	.88
119. kweyk	.16	.19	.61	.49	.20	.18	.92	.92
120. kik	.15	.30	.18	.33	.23	.32	.88	.84
121. təg	.13	.08	.33	.40	.03	∅	.89	.80
122. bɔy∅	.91	.93	.93	.92	.87	.92	.95	.95
123. greyn	.23	.22	.65	.62	.28	.23	.95	.92
124. bayt	.62	.53	.28	.15	.41	.24	.92	.94
125. riyd	.17	.25	.53	.51	.11	.15	.94	.96
126. fyuwl	.16	.17	.91	.90	.37	.35	.93	.92
127. rəg	.62	.65	.36	.27	.04	.02	.92	.91
128. keyk	.26	.26	.41	.46	.30	.31	.90	.95
129. payl	.63	.43	.24	.34	.72	.44	.89	.88
130. kiy∅	.18	.10	.63	.74	.48	.57	.79	.87
131. blayt	.25	.28	.11	.06	.44	.30	.83	.93
132. ta̎b	.21	.17	.68	.62	.05	.03	.92	.94

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
133. tuwθ	.07	.14	.89	.93	.08	.07	.86	.95
134. bawt	.32	.32	.97	.94	.29	.25	.92	.84
135. kriym	.40	.36	.49	.42	.28	.32	.96	.91
136. tuwl	.08	.12	.66	.66	.64	.58	.91	.88
137. fir∅	.95	.91	.57	.57	.69	.74	.92	.94
138. wɔk	.84	.88	.82	.90	.77	.67	.90	.88
139. frayt	.64	.70	.69	.64	.72	.70	.93	.98
140. klik	.21	.18	.48	.43	.18	.17	.85	.84
141. ǰin	.19	.15	.26	.33	.11	.16	.85	.85
142. yɔn	.08	.05	.69	.71	.05	.08	.96	.95
143. kowd	.40	.37	.95	.93	.03	.03	.89	.91
144. tɔk	.13	.30	.66	.64	.50	.55	.95	.92
145. treyn	.26	.35	.70	.62	.26	.37	.90	.90
146. yuw∅	.41	.31	.98	1.00	.81	.84	.94	.96
147. tayp	.22	.26	.20	.17	.91	.90	.93	.94
148. bɔs	.84	.75	.56	.69	.40	.49	.91	.97
149. ruwm	.64	.63	.91	.93	.67	.67	.83	.84
150. fiyd	.72	.73	.72	.68	.07	.08	.94	.96
151. šap	.46	.51	.83	.73	.77	.81	.98	1.00

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
152. bruwm	.36	.35	.92	.88	.47	.50	.83	.88
153. biyt	.23	.35	.73	.65	.11	.16	.91	.88
154. dɔn	.08	.12	.52	.56	.04	.02	.93	.96
155. la̋m	.78	.74	.90	.88	.12	.12	.92	.95
156. tiym	.07	.08	.47	.51	.08	.05	.96	.92
157. bowt	.58	.56	.71	.71	.36	.40	.92	.83
158. layt	.69	.65	.24	.14	.38	.34	.74	.84
159. kap	.28	.21	.72	.78	.94	.96	.96	.93
160. bil	.34	.41	.68	.56	.74	.69	.92	.80
161. skuwl	.45	.43	.89	.86	.64	.73	.92	.85
162. riym	.47	.40	.57	.63	.19	.23	.92	.88
163. trik	.15	.10	.38	.36	.06	.08	.86	.87
164. ðawl	.30	.22	.97	.98	.42	.32	.86	.88
165. kwiyn	.20	.21	.46	.50	.10	.13	.90	.89
166. liyš	.27	.30	.68	.73	.21	.27	.84	.82
167. bin	.44	.44	.54	.48	.05	.09	.94	.92
168. θrɔŋ	.59	.77	.61	.57	.38	.37	.96	.84
169. wig	.70	.71	.35	.39	ð	.03	.93	.81
170. skiyð	.09	.08	.41	.59	.62	.76	.92	.80

	C-		-V-		-C		Percentage of Responses COMPLETE WORD	
	F	P	F	P	F	P	F	P
171. ∅ɔyl	.40	.37	.49	.47	.42	.35	.73	.58
172. swiyt	.71	.64	.43	.48	.38	.39	.89	.89
173. ∅ay∅	.27	.20	.53	.53	.46	.48	.89	.91
174. riǰ	.46	.44	.63	.66	∅	∅	.95	.84
175. skriym	.06	.08	.35	.38	.48	.46	.92	.94
176. bred	.65	.65	.14	.11	.10	.13	.94	.95
177. bit	.46	.41	.20	.29	.24	.27	.90	.88
178. fuwl	.89	.83	.93	.94	.61	.50	.95	.97
179. θiyf	.67	.72	.59	.65	.69	.78	.92	.96
180. čir∅	.52	.50	.32	.27	.89	.77	.92	.88
181. θəm	.86	.87	.87	.87	.80	.84	.94	.97
182. kar∅	.20	.34	.26	.54	.16	.39	.80	.96
183. riyf	.56	.48	.50	.48	.74	.62	.96	.96
184. šin	.19	.33	.27	.26	.19	.18	.88	.84
185. kaw∅	.27	.29	.97	1.00	.75	.84	.91	.88
186. ruwt	.71	.75	.86	.88	.32	.32	.89	.88
187. rɔŋ	.68	.67	.80	.85	.52	.27	.95	.93
188. puwl	.58	.66	.56	.55	.53	.62	.94	.96
189. čɔk	.55	.41	.46	.52	.42	.50	.90	.95

		C-		-V-		-C		Percentage of Responses COMPLETE WORD	
		F	P	F	P	F	P	F	P
190.	stiym	.34	.33	.42	.53	.05	.07	.92	.91
191.	ǰəǰ	.46	.32	.50	.40	.48	.36	.95	.92
192.	kɔl	.50	.41	.92	.93	.89	.73	.95	.96
193.	hil	.77	.92	.50	.42	.65	.68	.93	.80
194.	ǰab	.23	.20	.92	.85	.21	.14	.99	.99
195.	liyf	.29	.30	.35	.35	.66	.66	.94	.96
196.	hud	.50	.36	.49	.64	.37	.54	.81	.84
197.	fown	.72	.77	.53	.43	.14	.14	.87	.88
198.	smir∅	.55	.58	.18	.13	.27	.22	.80	.80

APPENDIX J

MODAL WORDS: MOST FREQUENT C-V-C RESPONSES

TEST II-v

				Most frequent responses per word					
Word	Responses %			C-		-V-		-C	
	F	P		F	P	F	P	F	P
1. skwiyz	.88	.92	.04	sw .70	sw .71	iy .60	iy .66	t .51	t .44
2. gräs	.85	.90	.05	gr .28	gr .39	ä .50	ä .46	s .49	s .52
3. prays	.85	.89	.04	pr .37	br .40	ay .58	ay .59	s .46	s .43
4. sɔŋ	.91	.92	.01	s .34	st .36	ɔ .65	ɔ .54	Ø .36	Ø .47
5. wič	.86	.84	.02	w .57	w .58	i .88	i .90	č .56	č .55
6. rek	.84	.85	.01	r .34	r .42	ey .51	ey .55	t n .26	n .38
7. čiyf	.89	.87	.02	č .46	š .42	iy .46	i .54	f .62	f .49
8. buwt	.55	.60	.05	b .40	p .59	uw .41	uw .43	š .29	š .44
9. gläs	.77	.76	.01	l .27	l .34	ä .61	ä .52	s .50	s .44
10. spriyØ	.70	.78	.08	spr .85	spr .82	i .80	i .65	ŋ .76	ŋ .63
11. dir	.64	.80	.16	h .25	s .26	ir .47	ir .40	Ø .72	Ø .55
12. sayn	.80	.82	.02	s .61	s .55	ä .34	ä .32	Ø .26	Ø .21
13. fɔg	.86	.93	.07	f .82	f .82	ɔ .55	ɔ .69	g .33	g .47
14. wik	.92	.95	.03	w .66	w .71	ey .45	ey .32	t .43	t .32
15. glayd	.92	.91	.01	l .54	l .63	ay .46	ay .54	t .35	t .45
16. kown	.90	.90	--	h .50	h .53	ow .96	ow .95	cc- .40	cc- .32
17. ruwl	.72	.77	.05	w .41	w r .39	uw .55	uw .59	l .38	l .53

Word	Response %			Most frequent responses per word					
				C-		-V-		-C	
	F	P		F	P	F	P	F	P
18. dɔr	.87	.89	.02	š .24	š .26	ɔr .54	ɔr .61	Ø .78	Ø .92
19. šred	.74	.76	.02	str .41	str .49	ey .60	ey .54	t .30	t .38
20. spiyd	.74	.80	.06	sp .81	sp .88	iy .68	iy .64	k .40	k .43
21. fut	.90	.87	.03	f .90	f .82	ər .38	u .43	t .39	t .47
22. reyn	.92	.92	--	w .43	r .50	e .38	ey .46	l .33	n .28
23. rowz	.68	.75	.07	r .79	r .85	ow .88	ow .81	z .46	z .52
24. feyt	.96	.97	.01	f .84	f .90	ey .45	ey .39	s .41	s .34
25. fig	.86	.84	.02	f .67	f .82	iy .37	iy .26	Ø .31	Ø .26
26. liyč	.70	.65	.05	l .46	l .56	iy .57	iy .56	č .61	č .46
27. lowd	.71	.70	.01	l .39	l .49	ow .47	ow .44	z .35	Ø .27
28. sfir	.44	.46	.02	sf .40	sf .50	ir .57	ir .57	Ø .66	Ø .77
29. hed	.90	.88	.02	h .67	h .63	ä .66	ä .49	t .37	t .37
30. θiŋ	.94	.93	.01	đ .71	θ .55	er .39	i .50	Ø .54	Ø .33
31. sniyz	.84	.90	.06	s .44	s .46	i .28	i .39	t .25	cc- .28
32. ruwf	.89	.91	.02	r .81	r .81	uw .93	uw .93	f .85	f .82
33. wiyd	.89	.96	.07	w .72	w .78	i .40	i .39	t .24	cc+ .28
34. gir	.74	.79	.05	h .47	h .57	ir .68	ir .70	Ø .91	Ø .84
35. tap	1.00	1.00	--	st .60	st .63	a .92	a .94	p .99	p .98
36. bəs	.92	.75	.17	b .56	b .48	ə .32	ey .26	s .52	s .44
37. wul	.92	.92	--	w .91	w .86	u .58	u .52	l .58	l .57
38. θəg	.90	.92	.02	đ .56	θ .54	ə .35	i .30	Ø .57	Ø .29

Word	Response %			Most frequent responses per word					
				C-		-V-		-C	
	F	P		F	P	F	P	F	P
39. kyuw∅	.90	.95	.05	y .48	y .47	uw .93	uw .94	∅ .88	∅ .92
40. səm	.89	.87	.02	st .62	st .63	a .38	a .43	p .74	p .61
41. prowz	.91	.85	.06	b .40	b .52	ow .86	ow .88	t .28	t .38
42. slayd	.83	.81	.02	sl .32	sl .31	ay .43	ay .45	d .25	d .28
43. pat	.93	.95	.02	b .71	b .64	a .60	a .66	cc- .50	cc- .48
44. hwiyt	.90	.94	.04	w .70	w .70	i .39	ey .29	t .41	t .40
45. spuwl	.90	.90	--	sp .84	sp .80	uw .90	uw .87	l .55	l .55
46. deyt	.90	.91	.01	t .33	t .29	ey .43	e .37	t .35	cc+ .31
47. gəm	.95	.95	--	∅ .54	∅ .42	ə .80	ə .79	p .85	p .72
48. ruwž	.81	.84	.03	r .57	r .56	uw .58	uw .57	ž .29	š .33
49. powz	.88	.76	.12	b .68	b .72	ow .88	ow .85	t .58	t .55
50. zuw∅	.92	.98	.06	t .24	š .27	uw .95	uw .96	∅ .61	∅ .63
51. twič	.86	.81	.04	sw .74	sw .88	i .81	i .92	č .69	č .73
52. briyd	.91	.89	.02	br .78	br .75	ey .40	i .45	ŋ .29	ŋ .30
53. šuw∅	.89	.94	.05	š .47	š .48	uw .93	uw .93	∅ .82	∅ .77
54. fayt	.97	.96	.01	f .88	f .86	ay .71	ay .55	t .75	t .62
55. näp	.82	.88	.06	l .53	l .62	ä .85	ä .85	p .70	p .84
56. guws	.76	.88	.12	h .36	h .33	uw .74	uw .84	z .36	s .39
57. hɔl	.97	.96	.01	∅ .52	∅ .47	ɔ .81	ɔ .85	l .85	l .92
58. skiym	.81	.81	--	st .41	sl .34	iy .30	iy .48	p .84	p .84
59. freyt	.92	.97	.05	fr .75	fr .76	ay .53	ay .42	t .64	t .64

Word	Response %			Most frequent responses per word C-				-V-				-C			
	F	P		F		P		F		P		F		P	
60. čin	.81	.79	.02	č	.49	č	.55	iy	.24	i	.24	∅	.52	∅	.38
61. dɔg	.92	.93	.01	t	.24	t	.24	ɔ	.62	ɔ	.70	k	.37	k	.40
62. siyǰ	.64	.65	.01	t	.34	t	.36	iy	.44	i	.48	č	.74	č	.66
63. bid	.93	.95	.02	b	.50	b	.50	i	.37	iy	.55	t	.26	∅	.27
64. myuwl	.83	.87	.04	bl	.40	bl	.46	uw	.68	uw	.76	∅	.56	∅	.59
65. twiyd	.79	.80	.01	sw	.66	sw	.71	i	.48	i	.53	ŋ	.33	ŋ	.34
66. sir	.74	.75	.01	s	.40	s	.47	ow	.36	ow	.30	∅	.33	∅	.44
67. kat	.99	.93	.06	h	.78	h	.68	a	.70	a	.67	t	.76	t	.67
68. siv	.80	.83	.03	s	.41	st	.50	i	.45	i	.62	f	.53	f	.61
69. tuwb	.89	.88	.01	s	.33	s	.24	uw	.96	uw	.96	p	.77	p	.65
70. ∅ir	.77	.87	.10	h	.74	h	.79	ir	.65	ir	.68	∅	.94	∅	.87
71. fɔn	.78	.83	.05	f	.88	f	.71	ɔ	.74	ɔ	.82	g	.40	g	.52
72. byuwt	.80	.78	.02	b	.60	b	.56	uw	.64	uw	.81	t	.44	t	.42
73. speyn	.83	.80	.03	sp	.53	sp	.54	ay	.64	ay	.48	l	.45	l	.36
74. teyp	.92	.88	.04	st	.54	st	.46	ä	.68	ä	.61	p	.70	p	.77
75. bet	.89	.83	.06	b	.51	b	.45	ä	.42	ey	.44	t	.35	cc+	.38
76. yir	.92	.90	.02	y	.35	y	.29	uw	.79	uw	.57	∅	.71	∅	.62
77. kiŋ	.84	.87	.03	h	.36	h	.61	ä	.21	ey	.29	∅	.44	∅	.54
78. luwm	.86	.82	.04	l	.25	gr	.27	uw	.94	uw	.92	p	.84	p	.81
79. čəm	.89	.86	.03	ǰ	.42	ǰ	.40	ə	.48	$\overset{a}{ə}$	.41	p	.54	p	.57
80. gäs	.96	.93	.03	k	.35	l	.33	ä	.84	ä	.78	t	.41	cc+	.36

Word	Response %			Most frequent responses per word											
				C-				-V-				-C			
	F	P		F		P		F		P		F		P	
81. siyd	.84	.88	.04	s	.57	s	.61	i	.53	iy	.52	l	.36	∅	.39
82. beyt	.97	.96	.01	b	.48	b	.54	ä	.36	ey	.44	t	.38	t	.28
83. weyk	.95	.95	--	w	.63	w	.71	ey	.64	ey	.64	t	.35	t	.36
84. flayt	.93	.92	.01	f	.39	f	.40	ay	.33	ay	.36	t	.56	t	.59
85. suwp	.85	.86	.01	s	.48	s	.45	uw	.91	uw	.87	p	.87	p	.89
86. lowf	.74	.74	---	l	.54	l	.45	ow	.55	ow	.46	f	.85	f	.82
87. šɔl	.83	.90	.07	š	.42	š	.40	ɔ	.64	ɔ	.72	l	.70	l	.74
88. splays	.76	.73	.03	sp	.43	sp	.54	ay	.37	ey ay	.29	s	.47	s	.55
89. hyuw∅	.93	.96	.03	y	.54	y	.51	uw	.96	uw	.96	∅	.84	∅	.84
90. siym	.86	.89	.03	st	.40	sl	.40	e	.34	iy	.36	p	.90	p	.98
91. dič	.73	.67	.06	t	.42	d	.50	iy	.39	iy	.42	č	.69	č	.75
92. bät	.93	.91	.02	b	.44	p	.45	ä	.79	ä	.80	t	.41	t	.45
93. keyn	.82	.86	.04	k	.25	k	.26	ä	.39	ä	.34	∅	.25	∅	.29
94. buk	.97	.98	.01	b	.69	b	.71	u	.59	u	.77	k	.47	k	.61
95. striym	.86	.87	.01	sw	.48	sw str	.31	i	.64	i	.76	p	.45	p	.49
96. vɔys	.90	.81	.09	f	.83	f	.77	ɔr	.44	ɔr	.40	s	.50	s	.48
97. kwäk	.81	.78	.03	hw	.31	hw	.34	ä	.44	ä	.46	k	.40	k	.39
98. θɔt	.97	.96	.01	θ	.94	θ	.94	ɔ	.92	ɔ	.92	t	.89	t	.89
99. wiŋ	.89	.95	.06	w	.61	w	.56	ey	.37	ey	.25	∅	.60	∅	.43
100. huwč	.91	.83	.08	h	.52	h	.51	uw	.69	uw	.72	z	.46	z	.38
101. riyθ	.93	.96	.03	w	.93	w	.91	i	.94	i	.93	đ	.85	đ	.85

Word	Response %			Most frequent responses per word					
				C-		-V-		-C	
	F	P		F	P	F	P	F	P
102. lik	.89	.88	.01	l .43	l .40	i .52	i .65	k .24	k .29
103. θɔŋ	.92	.98	.06	θ .76	θ .79	ɔ .79	ɔ .83	Ø .47	t .55
104. tin	.91	.84	.07	s .25	s .23	i .48	i .48	l .29	l k .21
105. dowØ	.94	.95	.01	s .22	š .39	ow .77	ow .74	Ø .75	Ø .81
106. bruwt	.83	.90	.07	p .45	p .60	u .44	uw .49	š .38	š .41
107. niys	.84	.89	.05	l .48	l .40	i .42	i .41	cc+ .34	s .31
108. bluwm	.72	.70	.02	bl .51	bl .40	uw .75	uw .87	p .37	m .35
109. driym	.89	.86	.03	sw .28	str .28	i .57	i .62	p .51	p .53
110. kowt	.85	.79	.06	h .37	h .49	ow .89	ow .84	t .27	z .25
111. stuwl	.90	.88	.02	sk .25	š .40	uw .87	uw .83	l .46	Ø .56
112. prayz	.95	.96	.01	br .49	br .58	ay .81	ay .82	t .46	t .56
113. šed	.87	.83	.04	š .49	š .45	ey .48	e .29	k .32	t .21
114. kowl	.95	.96	.01	g .36	k .33	ow .92	ow .97	l .33	l .35
115. θred	.88	.89	.01	θr .59	θr .78	e .44	e .54	Ø .28	d .36
116. riŋ	.91	.96	.05	r .38	r .61	ey .41	ey .34	Ø .45	Ø .28
117. fəǰ	.96	.91	.05	fr .51	f .56	e .56	i .44	š .69	š .79
118. fin	.96	.88	.08	f .69	f .71	iy .33	iy .42	Ø .34	Ø .29
119. kweyk	.92	.92	--	w .50	w .50	ey .61	ey .49	t .32	t .34
120. kik	.88	.84	.04	l .30	k .30	ey .32	i .33	Ø .34	k .32
121. təg	.89	.80	.09	st .28	st .32	ə .33	ə .40	Ø .27	k .33
122. bɔyØ	.95	.95	--	b .91	b .93	ɔy .93	ɔy .92	Ø .87	Ø .92

Word	Response %			Most frequent responses per word					
				C-		-V-		-C	
	F	P		F	P	F	P	F	P
123. greyn	.95	.92	.03	tr .28	r gr .22	ey .65	ey .62	Ø .36	Ø .26
124. bayt	.92	.94	.02	b .62	b .53	ay .28	ey .37	t .41	s .38
125. riyd	.94	.96	.02	w .43	w .36	iy .53	iy .51	Ø .20	n .21
126. fyuwl	.93	.92	.01	f .68	f .68	uw .91	uw .90	l .37	l .35
127. rəg	.92	.91	.01	r .62	r .65	ə .36	ə ay .27	n .36	n .36
128. keyk	.90	.95	.05	k .26	k .26	ey .41	ey .46	t k .30	k .31
129. payl	.89	.88	.01	p .63	b .45	ä .36	ä .42	l .72	l .44
130. kiyØ	.79	.87	.08	h .26	h .40	iy .63	iy .74	Ø .48	Ø .57
131. blayt	.83	.93	.10	pl .43	pl .50	ey .44	ey .44	t .44	t .30
132. täb	.92	.94	.02	st .42	st .42	ä .68	ä .62	p .75	p .76
133. tuwθ	.86	.95	.09	š .34	š .36	uw .89	uw .93	Ø .32	Ø .39
134. bawt	.92	.84	.08	m .40	m .42	aw .97	aw .94	s .36	s .38
135. kriym	.96	.91	.05	kr .40	kr .36	iy .49	i .53	p .60	p .60
136. tuwl	.91	.88	.03	sk .19	sk .33	uw .66	uw .66	l .64	l .58
137. fir	.92	.94	.02	f .95	f .91	ir .58	ir .57	Ø .69	Ø .74
138. wɔk	.90	.88	.02	w .84	w .88	ɔ .82	ɔ .90	k .77	k .68
139. frayt	.93	.98	.05	fr .64	fr .70	ay .69	ay .64	t .72	t .70
140. klik	.85	.84	.01	l .30	h .30	i .48	i .43	Ø .23	Ø .28
141. ǰin	.85	.85	--	č .48	č .44	iy .36	iy .34	Ø .37	Ø .38
142. yɔn	.96	.95	.01	d .22	t .23	ɔ .69	ɔ .71	k .25	k .27
143. kowd	.89	.91	.02	k .40	k .37	ow .95	ow .93	t .42	t .35

Word	Response %			Most frequent responses per word C-		-V-		-C	
	F	P		F	P	F	P	F	P
144. tɔk	.95	.92	.03	č .35	t .30	ɔ .66	ɔ .64	k .50	k .55
145. treyn	.90	.90	--	str .36	str .36	ey .70	ey .62	n .26	n .37
146. yuwø	.94	.96	.02	y .41	y .31	uw .98	uw 1.00	ø .81	ø .84
147. tayp	.93	.94	.01	st .54	st .47	a .50	a .53	p .91	p .90
148. bɔs	.91	.97	.06	b .84	b .75	ɔ .56	ɔ .69	s .40	s .49
149. ruwm	.83	.84	.01	r .64	r .63	uw .91	uw .93	m .67	m .67
150. fiyd	.94	.96	.02	f .72	f .73	iy .72	iy .68	l .26	ø .31
151. šap	.98	1.00	.02	š .46	š .51	a .80	a .73	p .77	p .81
152. bruwm	.83	.88	.05	br .36	br .35	uw .92	uw .88	m .48	m .50
153. biyt	.91	.88	.03	p .62	p .41	iy .73	iy .65	s .50	s .26
154. dɔn	.93	.96	.03	č .30	č .26	ɔ .52	ɔ .56	k .36	k .40
155. läm	.92	.95	.03	l .78	l .74	ä .90	ä .88	p .53	p .58
156. tiym	.96	.92	.04	sl .42	sl .34	iy i .47	iy .51	p .91	p .90
157. bowt	.92	.83	.09	b .58	b .56	ow .71	ow .71	t .36	t .40
158. layt	.74	.84	.10	l .69	l .65	ey .28	ä .28	t .38	t .34
159. kap	.96	.93	.03	h .41	h .56	a .72	a .78	p .94	p .96
160. bil	.92	.80	.03	p .53	p .43	i .68	i .56	l .74	l .69
161. skuwl	.92	.85	.07	sk .45	sk .43	uw .89	uw .86	l .64	l .73
162. riym	.92	.88	.04	r .47	r .40	iy .58	iy .63	p .77	p .71
163. trik	.86	.87	.01	str .28	str .49	i .38	i .36	t .24	t .36
164. owl	.86	.88	.02	h .66	h .75	aw .97	aw .98	ø .48	ø .61

				Most frequent responses per word					
Word	Response %			C-		-V-		-C	
	F	P		F	P	F	P	F	P
165. kwiyn	.90	.89	.01	w .30	w .31	iy .46	iy .50	Ø .30	Ø .26
166. liyš	.84	.82	.02	t .37	t .38	iy .68	iy .73	č .66	č .68
167. bin	.94	.92	.02	b .44	b .44	i .54	i .48	l .43	Ø .35
168. θrɔŋ	.96	.84	.12	θr .59	θr .77	ɔ .61	ɔ .57	Ø .42	Ø .43
169. wig	.93	.81	.12	w .70	w .71	i .35	i .39	n l Ø .24	n .25
170. skiyØ	.92	.80	.12	s .46	s .51	iy .41	iy .59	Ø .62	Ø .76
171. ɔyl	.73	.58	.15	Ø .40	Ø .37	ɔy .49	ɔy .47	l .42	l .35
172. swiyt	.89	.89	--	sw .71	sw .64	i .53	iy .48	t .38	t .39
173. ØayØ	.89	.91	.02	h .65	h .71	ay .53	ay .53	Ø .46	Ø .48
174. riǰ	.95	.84	.11	r .46	r .44	i .63	i .66	č .66	č .61
175. skriym	.92	.94	.02	sw .76	sw .76	i .56	i .54	m .48	m .46
176. bred	.94	.95	.01	br .65	br .65	ey .51	ey .57	t .32	k .30
177. bit	.90	.88	.02	b .46	p .47	iy .46	iy .55	s .39	s .33
178. fuwl	.95	.97	.02	f .89	f .83	uw .93	uw .94	l .61	l .50
179. θiyf	.92	.96	.04	θ .67	θ .72	iy .59	iy .65	f .69	f .78
180. čir	.92	.88	.04	č .52	č .50	uw .40	uw .28	Ø .89	Ø .77
181. θəm	.94	.97	.03	θ .86	θ .87	ə .87	ə .87	m .80	m .84
182. kar	.80	.96	.16	h .48	h .40	ɔ .60	ar .54	l .59	l .39
183. riyf	.96	.96	--	r .56	r .48	iy .50	iy .48	f .74	f .62
184. šin	.88	.84	.04	č .56	č .53	iy .31	i .26	Ø .41	Ø .44
185. kawØ	.91	.88	.03	h .52	h .63	aw .97	aw 1.00	Ø .75	Ø .84

Word	Response %			Most frequent responses per word C-		-V-		-C	
	F	P		F	P	F	P	F	P
186. ruwt	.89	.88	.01	r .71	r .75	uw .86	uw .88	t .32	t .32
187. rɔŋ	.95	.93	.02	r .68	r .67	ɔ .80	ɔ .85	ŋ .52	ŋ .43
188. puwl	.94	.96	.02	p .58	p .66	uw .56	uw .55	l .53	l .62
189. čɔk	.90	.95	.05	č .55	č .41	ɔ .46	ɔ .52	k .42	k .50
190. stiym	.92	.91	.01	sl .44	st sl .33	iy .42	iy .53	p .91	p .90
191. ǰəǰ	.95	.92	.03	ǰ .46	č .47	ə .50	ə .40	ǰ .48	č .38
192. kɔl	.95	.96	.01	k .50	k .41	ɔ .92	ɔ .93	l .89	l .73
193. hil	.93	.80	.13	h .77	h .92	i .50	i .42	l .65	l .68
194. ǰab	.99	.99	--	š .45	š .45	a .92	a .85	p .77	p .77
195. liyf	.94	.96	.02	l .29	l .30	i .58	i .58	f .66	f .66
196. hud	.81	.84	.03	h .50	h .36	u .49	u .64	d .37	d .54
197. fown	.87	.88	.01	f .72	f .77	ow .53	ow .43	t .23	d .26
198. smir	.80	.80	--	sm .55	sm .58	e .46	e .50	l .61	l .55

APPENDIX K

Cover Page, Test III

Studies in Visual Communication
Linguistics Project

Form III-V

____

Test III - V - ____________

G____________S____________

____________ Please do not write above this line____________

Your cooperation is requested in a project designed to improve techniques for teaching lipreading to the deaf and hard of hearing. To aid in interpreting the results, please provide the personal information requested. Your answers will be kept confidential.

1. Name____________________________________
2. Sex: M______F______ 3. Age____________
4. Mailing Address____________________________
5. Is English your native language?______If not, what is?____________
6. What other languages do you speak or understand?____________
7. Do you have a hearing loss?______If yes, please indicate degree & duration:

   Hard of hearing ______
   Severely deaf ______
   Profoundly deaf ______

   since birth____________
   number of years____________
8. Have you ever practiced lipreading?______If yes, how long?__________
9. Do you have normal vision?____________________
10. COMMENTS: You are invited to state your reactions to the film or to add anything to the questionnaire which you feel might be helpful in an analysis of lipreading. You may use the back of this page for these remarks.

INSTRUCTIONS

You are about to see a silent film which was made to see how easily certain English sounds may be identified by lipreading. In the film a speaker is pronouncing a series of nonsense syllables, for example: /pah/, /fah/, /ah/, etc. Each of these syllables is numbered. In the space following the corresponding number on the answer sheet, please write down the initial sound which you think was pronounced. All of the following English consonants are included at least once in the film:

p b m hw w f v θ đ t d s z n l r č ǰ š ž y k g h ∅

Please do not leave any spaces blank. If you do not feel certain, you may guess.

APPENDIX L

Script for Film Test III

1. la
2. ča (cha)
3. na
4. ya
5. va
6. ha
7. ǰa (ja)
8. θa (tha)
9. aa
10. ra
11. đa (~~th~~a)
12. ša (sha)
13. aa
14. da
15. ta
16. ča (cha)
17. wa
18. θa (tha)
19. Wa (hwa)
20. da
21. ra
22. ža (zha)
23. na
24. ǰa (ja)
25. va
26. ya
27. ba
28. Wa (hwa)
29. ga
30. za
31. wa
32. la
33. ǰa (ja)
34. ta
35. fa
36. đa (~~th~~a)
37. ka
38. za
39. wa
40. θa (tha)
41. ba
42. ča (cha)
43. la
44. ga
45. ša (sha)
46. da
47. ya
48. sa
49. ma
50. fa
51. ka
52. ba
53. pa
54. va
55. ha
56. na
57. ra
58. ža (zha)
59. pa
60. ma
61. ga
62. fa
63. pa
64. aa
65. sa
66. ša (sha)
67. ža (zha)
68. ma
69. Wa (hwa)
70. đa (~~th~~a)
71. ka
72. za
73. sa
74. ta
75. ha

APPENDIX M.

COVER PAGE, TEST IV

JOHN TRACY CLINIC
Studies in Visual Communication
Linguistics Project

FORM IV-v

____

Test IV-v- ________

G________ S ________

PLEASE DO NOT WRITE ABOVE THIS LINE

Your cooperation is requested in a project designed to improve techniques of lipreading for the deaf and hard of hearing. To aid in interpretation of results, please provide the personal information requested below. Your answers will be kept confidential.

1. Name ________________________________

2. Sex: M_____ F_____

3. Age__________

4. Mailing address __________________________

5. Is English your native language? _____If not, what is?__________

6. What other languages do you speak or understand?____________

7. Do you have a hearing loss? _____ If yes, please indicate degree and duration:

   Hard of hearing_____
   Severely deaf _____
   Profoundly deaf _____

   Since birth____________
   Number of years__________

8. Have you practiced lipreading? _____ If yes, how long? ________

9. Do you have normal or corrected vision? _______________

10. COMMENTS: You are invited to state your reactions to the film or to add anything to this questionnaire which you feel might be helpful in an analysis of lipreading. You may use the back of this page for remarks.

INSTRUCTIONS

You are about to see a silent film which was made to test how easily certain words may be identified by lipreading. In the film, a speaker is pronouncing a series of one-syllable English words, each of which is numbered. In the spaces following the corresponding number on the answer sheets, please check (X) which of two words you think was pronounced. Do not be bothered by repetitions; i.e., judge each comparison separately, and don't be surprised if a word occurs more than once in the test.

Please ignore the printed instructions at the beginning of the film, except as an example of lipreading: you are not required to write words on the answer sheets; simply place a check mark to indicate which word you think you saw. We will be glad to answer any questions you may have about the project after the film has been shown.

APPENDIX N.

ANSWER SHEETS, TEST IV*

____

FORM IV
Page 1.

Test IV- ____________

G ________ S ________

——— PLEASE DO NOT WRITE ABOVE THIS LINE ———

1.	____ sweet	X squeeze	18.	X door	____ dough
2.	____ rose	X grass	19.	X shred	____ shed
3.	X price	____ prize	20.	____ reed	X speed
4.	X song	____ shawl	21.	X foot	____ phone
5.	X witch	____ ridge	22.	____ train	X rain
6.	X wreck	____ wick	23.	____ grass	X rose
7.	____ sieve	X chief	24.	____ freight	X fate
8.	X boot	____ boat	25.	X fig	____ fin
9.	____ gas	X glass	26.	X leech	____ leash
10.	X spree	____ smear	27.	____ loaf	X load
11.	____ seer	X deer	28.	____ fear	X sphere
12.	____ slide	X sign	29.	X head	____ hood
13.	____ fawn	X fog	30.	____ thug	X thing
14.	X wick	____ wreck	31.	____ niece	X sneeze
15.	X glide	____ light	32.	____ voice	X roof
16.	____ coal	X cone	33.	____ wheat	X weed
17.	X rule	____ wool	34.	X gear	____ ear

---

*Correct answers--i.e., actual stimulus words presented--are indicated by check marks in the appropriate column (cf. Appendix G, Film Script).

FORM IV
Page 2.

Test IV- ______

G______ S______

PLEASE DO NOT WRITE ABOVE THIS LINE

35. X top ____type
36. X bus ____book
37. ____rule X wool
38. ____thing X thug
39. ____hue X cue
40. ____chum X sum
41. ____pose X prose
42. X slide ____sign
43. X pot ____boss
44. X wheat ____weed
45. X spool ____boy
46. ____dog X date
47. X gum ____cop
48. ____root X rouge
49. X pose ____prose
50. X zoo ____school
51. ____trick X twitch
52. X breed ____bread
53. X shoe ____stool
54. X fight ____feed
55. X nap ____lamb
56. ____hooch X goose
57. X hall ____call
58. X scheme ____team
59. ____fate X freight
60. X chin ____gin
61. ____date X dog
62. ____ditch X siege
63. ____bin X bid
64. X mule ____pool
65. ____queen X tweed
66. ____deer X seer
67. ____cane X cot
68. ____chief X sieve
69. ____soup X tube
70. ____gear X ear
71. X fawn ____fog
72. ____brute X butte
73. ____splice X spine
74. ____tab X tape

FORM IV
Page 3.

____

Test IV- ____________

G ________ S ________

PLEASE DO NOT WRITE ABOVE THIS LINE

75.	____ bait	X bet
76.	____ you	X year
77.	____ key	X king
78.	X loom	____ room
79.	X chum	____ sum
80.	X gas	____ glass
81.	X seed	____ scream
82.	____ bet	X bait
83.	____ quake	X wake
84.	____ fright	X flight
85.	____ tube	X soup
86.	X loaf	____ load
87.	____ song	X shawl
88.	____ spine	X splice
89.	X hue	____ cue
90.	X seam	____ steam
91.	____ siege	X ditch
92.	____ bite	X bat
93.	X cane	____ cot
94.	____ bus	X book
95.	____ dream	X stream
96.	X voice	____ roof
97.	X quack	____ walk
98.	X thought	____ thong
99.	X wing	____ wig
100.	X hooch	____ goose
101.	X wreath	____ reef
102.	X lick	____ click
103.	X thong	____ thought
104.	X tin	____ shin
105.	____ door	X dough
106.	X brute	____ butte
107.	X niece	____ sneeze
108.	X bloom	____ broom
109.	____ stream	X dream
110.	____ code	X coat
111.	____ shoe	X stool
112.	X prize	____ price

FORM IV
Page 4.

Test IV- ____________
G__________ S__________

PLEASE DO NOT WRITE ABOVE THIS LINE

113.	____ shred	X shed	137.	X fear	____ sphere
114.	X coal	____ cone	138.	X walk	____ quack
115.	____ thumb	X thread	139.	X fright	____ flight
116.	X ring	____ grain	140.	X click	____ lick
117.	X fudge	____ judge	141.	X gin	____ chin
118.	X fin	____ fig	142.	____ dawn	X yawn
119.	X quake	____ wake	143.	____ coat	X code
120.	____ cake	X kick	144.	X talk	____ chalk
121.	____ rug	X tug	145.	X train	____ rain
122.	X boy	____ spool	146.	X you	____ year
123.	____ ring	X grain	147.	____ top	X type
124.	X bite	____ bat	148.	X boss	____ pot
125.	____ speed	X reed	149.	____ loom	X room
126.	X fuel	____ fool	150.	X feed	____ fight
127.	____ tug	X rug	151.	X shop	____ job
128.	____ kick	X cake	152.	X broom	____ bloom
129.	X pile	____ bill	153.	X beet	____ bit
130.	____ king	X key	154.	X dawn	____ yawn
131.	X blight	____ bout	155.	X lamb	____ nap
132.	____ tape	X tab	156.	____ scheme	X team
133.	X tooth	____ tool	157.	____ boot	X boat
134.	____ blight	X bout	158.	X light	____ glide
135.	____ ream	X cream	159.	X cop	____ gum
136.	____ tooth	X tool	160.	____ pile	X bill

FORM IV
Page 5.

TEST IV- ________
G________ S________

PLEASE DO NOT WRITE ABOVE THIS LINE

161.	____ zoo	X school
162.	____ cream	X ream
163.	X trick	____ twitch
164.	____ oil	X owl
165.	X queen	____ tweed
166.	____ leech	X leash
167.	____ bid	X bin
168.	X throng	____ wrong
169.	X wig	____ wing
170.	X ski	____ cheer
171.	____ owl	X oil
172.	____ squeeze	X sweet
173.	____ hill	X eye
174.	____ witch	X ridge
175.	____ seed	X scream
176.	X bread	____ breed
177.	____ beet	X bit
178.	____ fuel	X fool
179.	X thief	____ leaf
180.	X cheer	____ ski
181.	____ thread	X thumb
182.	X car	____ cow
183.	X reef	____ wreath
184.	____ tin	X shin
185.	____ car	X cow
186.	____ rouge	X root
187.	X wrong	____ throng
188.	____ mule	X pool
189.	____ talk	X chalk
190.	X steam	____ seam
191.	____ fudge	X judge
192.	____ hall	X call
193.	____ eye	X hill
194.	X job	____ shop
195.	X leaf	____ thief
196.	____ head	X hood
197.	X phone	____ foot
198.	X smear	____ spree

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